Columbia/Snake Rivers Temperature TMDL
Draft November 13, 2002

List of Figures

Page

List of Tables

Do we need a "Bill Riley" chart?

My view...
(1) WQS
(2) 303(d)
(3) TMDL
(4) Implementation
(5) Adjustments
(a) new sources
(b) trading
(c) new information
(1) determination that highest use has been attained.

Executive Summary

The Role of this TMDL and the Overall Water Quality Improvement Process

The overall process for improving water quality as laid out in the Clean Water Act involves several steps. First, the desired water quality is defined via state water quality standards. Second, waters of a lower quality than the water quality standards are identified on state 303(d) lists (also known as "Lists of Impaired Waterbodies"). Third, a Total Maximum Daily Load (TMDL) is established for waters on the 303(d) list. Fourth, implementation plans are developed by the state to achieve the TMDL. Fifth, ~~in some cases, a balance must be struck between the TMDL and the water quality standards~~. implementation to reassessment of During implementation planning, it may become clear that there are no feasible improvement alternatives that will achieve the TMDL. In these cases, the TMDL and the water quality standards may have to be adjusted to achieve the highest levels of water quality that are feasible. Finally, the TMDL is implemented through the NPDES Permit Program, State Water Quality Standards Certification Program, the States Non-point Source Management Program and other appropriate mechanisms.

Often the TMDL and the implementation plan are developed together and there may even be iterative ~~manipulation~~ development of the two until a workable mix is achieved. In the case of the main stems temperature TMDL, the two have been kept some what separated. Interest in temperature in the main stems peaked during development of the 2000 Federal Columbia River Power System (FCRPS) Biological Opinion by the National Marine Fisheries Service (NMFS) and the Fish and Wildlife Service (FWS). Many believed that elevated temperatures played a role in the reduction of salmon runs, while others believed that temperature in the main stems had not changed significantly from natural conditions. Further, the water quality standards do not establish a clear target for temperature and require considerable analysis. So it wasn't clear if there was a temperature problem, how severe it was or what was causing it. Implementation planning to improve water temperature could be very costly, especially for the federal and public utility district dams on the rivers. Therefore, it is prudent to verify that a problem exists and to quantify the extent of the problem before investing a great deal. Essentially, the role of this TMDL in improving temperature in the Columbia/Snake River main stems is to clarify these issues. The purpose of this TMDL is to:

2 ~~1~~. define the temperature targets;
1 ~~2~~. quantify the temperature problem on the main stems;
3 3. determine the level of improvement needed.

estimate current conditions as well as ~~determine~~ conditions in the absence of human activities.

The TMDL, ~~therefore,~~ uses water quality modeling to ~~estimate~~ ~~determine the specific~~ appropriate water temperature targets for the main stems on the basis of state water quality standards. The water quality standards require identification of what the temperatures would be in the absence of human activities on the main stems. Having determined the temperature regime required by the state water quality standards, the TMDL evaluates whether the existing main stems achieve those target temperature regimes and quantifies the contributions of existing human activities to temperature increases in the river. This TMDL finds that temperature does exceed the target temperature regimes required by state water quality standards so it goes on to quantify the improvement needed and allocate heat loads to the various human activities on the main stems that, if achieved, will result in compliance with the target temperatures.

The next step in improving temperature in the main stems is to develop the implementation plan. That is, determine what specific operational changes at the dams and point sources of heat along the rivers can be implemented to achieve the TMDL and ultimately achieve water quality standards. In other words, what feasible alternatives are available to improve temperature. The TMDL identifies some of the dams on the main stems to be the major contributors to temperature increases in the main stems. Implementation planning to achieve temperature improvements at dams will be technically complicated, costly and generally outside Clean Water Act authorities. The federal dams were specifically authorized by Congress for specific purposes such as flood control, power generation, irrigation and navigation. Decisions on the feasibility of alternatives to improve temperature at these facilities will have to consider the ability of the FCRPS to continue achieving the purposes established by Congress, the technical feasibility of the alternatives and the economic feasibility of the alternatives.

The states take the lead for TMDL implementation planning but they will rely heavily on the Federal Agencies that administer and operate the FCRPS. In fact, development of improvement alternatives will require a sytstem wide evaluation of the FCRPS and the Columbia/Snake River system. Improvements in temperature resulting from operation of the river system will rely heavily on regional, national and even international forums. Because of the complicated policy and technical issues incumbent on implementation planning, in this case, it could be a lengthy process.

However, that is not to say that the FCRPS has been inactive in planning and implementing measures to improve water temperature in the Columbia and Snake River main stems. The Bonneville Power Administration is financing sub-basin planning all over the Columbia Basin to improve salmon habitat, including temperature in the tributaries to the Columbia and Snake Rivers. The Corps of Engineers has operated Dworshak Dam for the last three years to discharge cooler water to improve temperature in the lower Snake River. Every year, the Corps works with EPA, NMFS and the states and tribes to refine and fine tune it's approach to operating the Dworshak Dam. Two major limitations on implementation planning have been the lack of data to adequately characterize water temperature and the lack of water quality modeling that can evaluate the effects of improvement alternatives at specific dams and site along the river. In 2002, the FCRPS agencies began an effort to address these limitations. Working with NMFS, FWS, EPA, the states and the tribes, the FCRPS agencies developed an interagency committee that is evaluating monitoring and modeling efforts on the rivers. That committee, chaired by the Corps and NMFS, will determine appropriate water quality models and the monitoring necessary to support those models. That committee has been very active and has resulted in intensive monitoring efforts in 2002, including monitoring of temperature in fish passage facilities. The Bureau of Reclamation has been active in working with EPA in development of the TMDL to ensure that there is an adequate understanding of the operation of Grand Coulee Dam and the Columbia Basin Irrigation Project and to brain storm improvement measures that can be evaluated to determine if they are feasible and will have a beneficial effect on water temperature downstream of Grand Coulee while not causing impairment of temperature upstream of the dam in Lake Roosevelt.

Continued cooperation of the federal agencies, the states and tribes will ensure that the implementation planning results in a balanced strategy that considers ecological needs above and below Grand Coulee, achievement of the Congressionally authorized purpose of the FCRPS and is technically feasible and economically achievable. Step 5 of the water quality improvement process is to alter the TMDL and the water quality standards, as appropriate, to strike this balance between competing ecological needs and competing uses and values of the river system. If it is not feasible to achieve the TMDL without sacrificing ecological needs upstream of Grand Coulee or the other uses of the river system, the water quality standards can be amended and the TMDL revised to achieve the new standards.

The EPA water quality standards regulations provide for situations where water quality standards cannot be attained. The regulations specifically address dams. At 40 CFR 131.10(g) the regulations say "States may remove a designated use which is not an existing use, as defined in Sec. 131.3, or establish sub-categories of a use if the state can demonstrate that attaining the designated use is not feasible because: ....(4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use." The regulations also address te concept of economic feasibility at 40 CFR 131.10(g)(6): "Controls more stringent than those required by sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact."

Sequentially, the final step in the improvement process is actual implementation of the measures to improve water quality. In actuality, implementation can occur simultaneously with the planning processes and in this case a great deal of work is being done to improve temperature in the Columbia and Snakes rivers as described above. The whole water quality improvement process outlined above, including the TMDL will be an iterative process. As the FCRPS agencies continue to work toward temperature improvements, develop water quality models and collect water quality data, the TMDL may updated.

Description of Waterbody, Pollutant of Concern, and Pollutant Sources

This Total Maximum Daily Load (TMDL) addresses water temperature in the mainstem segments of the Columbia River from the Canadian Border (River Mile 745) to the Pacific Ocean and the Snake River from its confluence with the Salmon River (River Mile 188) to its confluence with the Columbia River. The States of Oregon and Washington and the U.S. Environmental Protection Agency (EPA) have listed multiple segments of both mainstem reaches on their federal Clean Water Act (CWA) 303(d) lists due to water temperatures that exceed state water quality standards (WQS). The entire reaches of both rivers are considered impaired for water temperature. EPA is establishing this TMDL for waters within the States of Oregon and Washington and within the Reservations of the Confederated Tribes of the Colville Reservation and the Spokane Tribe of Indians. At this time, the Idaho Department of Environmental Quality is anticipating simultaneously issuing the TMDL for waters within the jurisdiction of the State of Idaho.

Water temperature can be elevated above natural conditions by a number of human activities. The primary sources of elevated temperatures in the Columbia and Snake Rivers are point sources, nonpoint sources, and dams. Point sources discharge thermal energy directly to the river. Nonpoint sources such as agricultural run off discharge to the rivers primarily via irrigation canals and tributaries. Dams alter river temperature by changing the flow regime, stream geometry, current velocity and flood plain interactions of the river.

The effects of point sources and tributaries (nonpoint sources) on cross sectional average water temperatures in the main stems are for the most part quite small. The point sources can cause temperature plumes in the near-field but they do not result in measurable increases to the cross-sectional average temperature of the main stems. That is, the cumulative impact of all the point sources is less than 0.14 °C when temperature criteria are exceeded in the river. Some of the dams, however, do cause measurable changes in the cross-sectional average temperature of the main stems. They increase the cross-sectional average temperature and they extend the period of time during which the water temperature exceeds numeric temperature criteria. The impact to water temperature of the dams ranges from very small at Priest Rapids where the maximum estimated impact is about 0.09 °C to the impact of Grand Coulee which is as high as 6.0 °C in the late fall. Eight of the 15 dams have maximum impacts to temperature of over 0.5 °C.

Description of the Applicable Water Quality Standards and Numeric Targets

The WQS for temperature on the Columbia and Snake Rivers are quite complex. The three states and one tribe with EPA-approved standards have adopted a variety of numeric and narrative criteria for temperature in the segments of the Columbia/Snake mainstems within their jurisdictions. A common component in all of the standards is a provision to account for times when natural water temperatures in the rivers exceed numeric water quality criteria. Generally, when this occurs, the standards allow only small incremental increases to the natural temperatures. Washington WQS, which apply to all of the TMDL project area except the upper 12 miles of the Snake River reach, also restrict incremental increases in temperature when the natural temperature is below numeric criteria. The TMDL is based on the most stringent standards that apply on the rivers reach by reach. Table S-1 summarizes the WQS standards that are the basis for this TMDL.

Table S-1: Summary of Water Quality Standards that Apply to the Columbia and Snake Rivers

Columbia River Reach	Criterion	Natural Temp < Criterion	Natural Temp > Criterion
Canadian Border to Grand Coulee Dam	16 °C DM	Natural + 23/(T+5)	Natural + 0.3 °C
Grand Coulee Dam to Chief Joseph Dam	16 °C DM	Natural + 23/(T+5)	Natural + 0.3 °C
Chief Joseph Dam to Priest Rapids Dam	18 °C DM	Natural + 28/(T+7)	Natural + 0.3 °C
Priest Rapids Dam to Oregon Border	20 °C DM	Natural + 34/(T+9)	Natural + 0.3 °C
Oregon Border to mouth	12.8/20 °C DM	Natural + 1.1 °C	Natural + 0.14°C
Snake River Reach	**Criterion**	**Natural Temp < Criterion**	**Natural Temp > Criterion**
Salmon River to OR/WA Border	12.8/17.8 °C 7DADM	Up to Criterion	Natural + 0.14 °C
OR/WA Border to ID/WA Border	20 °C DM	Natural + 1.1 °C	Natural + 0.3 °C
ID/WA Border to Mouth	20 °C DM	Natural + 34/(T+9)	Natural + 0.3 °C

T = the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.
DM = daily maximum temperature.
7DADM = seven day average of the daily maximum temperatures..

Development of the target temperatures for the TMDL depends on an understanding of natural temperature. A peer-reviewed, mathematical water quality model (Yearsley, 2001) was used to simulate temperature conditions in the mainstems of the Columbia and Snake Rivers in the absence of human activity in the mainstems. The simulations utilize existing flow and temperature in the tributaries and at the TMDL boundaries. These simulated temperatures are an approximation of natural conditions because they do not account for possible impacts from altered water temperature and flow regimes outside the TMDL project area. To maintain the distinction from purely natural temperatures, these simulated temperatures are referred to as site potential temperatures. This TMDL is based on the site potential temperatures; the temperatures that are estimated to occur in the absence of human activity in the mainstems.

The site potential temperatures in the mainstems vary considerably throughout the year, from year to year, and longitudinally along the rivers. To account for the temporal variation, the site potential temperatures are simulated using a thirty year data record and the target temperatures for the TMDL are expressed as thirty year mean temperatures for every day of the year. To account for the spatial variation, the rivers are divided into 21 longitudinal reaches with a TMDL Target Site at the down river end of each reach.

The mathematical model has been used to evaluate cumulative impacts of upstream temperature impacts on downstream segments of the TMDL. This analysis indicates that elevating temperatures of upstream segments to the degree allowed under the WQS (Table S-1) would result in exceedances of WQS in downstream segments. As a result, the target temperatures in the lower reach of the Columbia River drive the upstream allocations for this TMDL. Therefore, the target temperatures of each reach above the Oregon/Washington Border are lower than those indicated by Table S-1. The targets at each upper reach are lowered enough to ensure that the target temperature in the downstream reach are achieved. Figure S-1 illustrates the existing temperature and the TMDL target temperature at the John Day target site.

Application of the Target Temperatures

The target temperatures for this TMDL are expressed as daily cross sectional average temperatures. The cross sectional average temperature is representative of the free flowing river because it was generally well mixed. The target temperature must be achieved as a daily ~~cross~~ sectional average in the impounded river but also throughout the width and depth of the thalweg, in critical fish habitat and in fish ladders and holding facilities. "O"

?

Loading Capacity

The loading capacity is... the amount of pollutant the waterbody can receive and still meet WQS.

Focus on how handled LC, not temp. measure

The loading capacity is expressed as temperature rather than as thermal load. The regulations governing TMDL development provide for the expression of TMDLs as "either mass per time, toxicity, or other appropriate measure" (40CFR130.2(h)). Temperature is an appropriate ~~measure in this TMDL because dams play a major role in altering~~ the temperature regime of the river but they do not discharge water bearing a thermal load to the river. Dams alter the temperature regime of the river by altering the stream geometry and current velocity upstream of the dam. Expressing the loading capacity and allocations as temperatures addresses a potential concern that dam operators could choose to alter flow in the river to achieve thermal load targets without improving temperature. In this TMDL, the loading capacity is the daily ~~target~~ average site potential temperature at River Mile 4 of the Columbia River as depicted in Figure 5-1 and in Appendix B.

plus ~~add deg C~~ the allowable increment critical

They could also exceed TMDL with high flows at acceptable temperatures.

Pollutant Allocations (see Table S-2)

Point sources are allocated loads, and their loads are accounted for in the target temps.

process

The ~~underlying philosophy~~ used to establish this TMDL was to allocate available heat capacity to the smallest sources first and work up the list until the available capacity is fully allocated. That is, allocate existing heat load to as many sources as possible. This philosophy arises from the fact that there is insufficient capacity to provide the larger sources any meaningful relief since the total capacity to be allocated is only 0.14 °C most of the year. Therefore, the TMDL first allocates sufficient loads to account for existing discharges from individual NPDES permittees and 20 MW at each target site to account for general NPDES permittees. Any future growth will have to be part of the 20 MW allocated to general permits. The TMDL then allocates remaining capacity to account for as many of the dams as possible beginning with the dams with the smallest effect on temperature.

2 words, italics?

The analysis of NPDES point sources in the watershed indicates that the cumulative loading of temperature to be deminimus in comparison to the effects of the dams and never in and of itself results in exceedance of water quality standards. Even if this TMDL were to allocate the site potential temperature to each point source (ie., a wasteload equal to meeting water quality standards at the end of the discharge pipe), the applicable water quality standards would not be attained in the waterbody because of the temperature increases caused by the dams. In fact, very little benefit would be realized in terms of temperature reductions needed by the dams to achieve water quality standards. At the same time however, EPA recognizes that discharged heat may have local effects even at very small quantities, and as such, should be limited to the extent practicable. Taking these two considerations into account, this TMDL therefore provides a cumulative wasteload allocation applicable to all NPDES facilities in the mainstems that never exceeds 0.14 °C whenever site potential temperature is greater than the water quality criteria. That is, the cumulative effects of all the NPDES point sources is never measurable when the rivers exceed water quality criteria. EPA believes that the wasteload allocations in this TMDL are reasonable in light of the following factors.

1. The NPDES point sources, in the aggregate, contribute less than 0.14 °C to the total temperature within each reach when temperature exceeds water quality criteria;
2. Limiting the point source discharges to site potential temperatures will have no measurable effect on far-field water quality and reducing them beyond the levels contemplated by the cumulative wasteload allocation is not necessary to achieve water quality standards;
3. ~~The majority of the temperature increases (as much as 6 °C)~~ are cause ~~by the larger dams~~: ~~therefore, water quality standards cannot be achieved under Clean Water Act authorities,~~ ~~but rather need~~ to be accomplished through other federal, state, local and even, conceivably, ~~international mechanisms~~. point source enforcement

The load available for allocation is the temperature increment over the natural or site potential temperature allowed under the WQS. For example, at the furthest downstream point in the river, this increment is 0.14 °C when numeric criteria are exceeded and 1.1 °C the rest of the time. Much of this temperature increment is consumed by the allocations to the point sources as wasteload allocations (WLA). In the WLA, the load each point source can discharge to the river is expressed as megawatts (MW). There are 106 Point Sources with individual NPDES permits in this TMDL. All but 11 of these point sources have only a minimal effect on mainstem temperatures (defined for the purpose of this TMDL as less than 0.014 °C). These 95 smaller point sources are included in group allocations for each reach. The 11 larger point source dischargers receive individual allocations.

Based on model estimates,

EPA, Oregon and Washington have issued 27 general NPDES permits. Currently 16 of them have a total of 96 permittees that discharge to the Columbia or Snake Rivers. The contribution to temperature from the sources covered by the general permits is minimal; especially when compared to the temperature loads from large point sources and the impacts of the dams. An additional 20 megawatts is added to each group allocation to account for these sources.

The states will issue TMDLs for those tribs that exceed stds. These TMDLs will establish trib-specific target temps outside this mainstem process.

Since the site potential simulations incorporate existing tributary temperatures, none of the temperature increment is allocated to tributaries. All tributaries are allocated their existing loads.

The temperature increment remaining to be allocated after allocation to the point sources is very small and therefore, the temperature increase allocated to the 15 dams is also very small. Wells, Rocky Reach, Rock Island and Priest Rapids dams have very smal effects on water temperature. They are provided allocations that accounts for the small effects tat they currently have. The other dams receive no allocation over S. potential

Margin of Safety

Implicit margins of safety have been built into the TMDL. For point sources the WLA is based on reasonable worst case discharges. Further, the wasteload allocation for point sources does not vary with river flow. It achieves water quality standards at the 7Q10 low flow, thereby providing a margin of safety when flows are greater than the 7Q10. ~~For dams,~~ the use of daily average temperatures (as opposed to maximum temperatures only) is a conservative application of the WQS provisions regarding natural temperature conditions.

Seasonal Variation

how did we account for this - assumed worst case discharges??

The water quality standards for temperature, actual river temperature ~~itself~~ and the effects of human activities on temperature all vary seasonally during the year. In the winter and spring, water quality standards are not exceeded, and therefore the waters of the Columbia and Snake rivers are not impaired for temperature from human activities within the main stems. In the late summer and fall, water quality standards are exceeded and the site potential temperatures exceed the water quality criteria, requiring TMDL allocations for temperature that ensure temperature doesn't exceed site potential temperature + 0.14 °C. In the late fall and early winter water quality standards are exceeded but the site potential is less than water quality criteria requiring TMDL allocations that ensure temperatures don't exceed site potential + 1.1 °C. The seasonality of the TMDL is summarized as follows:

February 6 through July 31 - no allocations required;
August 1 through October 31 - allocations to achieve site potential Temperature + 0.14 °C;
November 1 through February 5 - allocations to achieve site potential Temperature + 1.1 °C.

(1) Model takes into account 30 yr. record of daily conditions throughout watershed. (2) Targets are established for each calendar day. (3) TMDL effectiveness must be evaluated over long term due to natural variability

Future Growth

A small portion of the available temperature increases has been allocated to future growth in the group allocations. Twenty MW of heat energy have been added to each group above that needed by the dischargers in the group.

not consistent with statement on previous page

Monitoring Plan

Long term, system wide effectiveness of TMDL implementation activities can be assessed by monitoring mainstem river temperatures at the target sites. Over the long term, if implementation is adequate, the daily mean temperatures at the target site should equal the 30 year mean target temperatures at those sites. Individual years may exceed those temperatures because of natural variation.

Short term monitoring for compliance with WLAs will be accomplished through effluent monitoring by the point sources. For individual dams, one option for short term monitoring is to evaluate the temperature difference between successive dams. The TMDL includes curves showing the temperature differences for existing conditions and for the conditions of the implemented TMDL. Effectiveness of TMDL implementation within individual impoundments can be determined by comparison of actual temperature differences between dams to the TMDL curves.

Implementation Plans

Implementation plans will be developed by the States and Tribes.

Public Participation

Extensive public involvement activities, organized by the inter-agency TMDL Coordination Team have occurred for this TMDL over the past two years. Activities have included websites, fact sheets, coordination meeting, individual meetings with interested groups, nine public workshops and numerous conference presentations. Public participation efforts will continue until the TMDL is finalized. Three public workshops are planned to review the preliminary draft TMDL and public meetings with the opportunity for public comment will be held during the draft TMDL comment period.

1.0 Introduction

1.1 The Role of this TMDL and the Overall Water Quality Improvement Process

The overall process for improving water quality as laid out in the Clean Water Act involves several steps. First, the desired water quality is defined via state water quality standards. Second, waters of a lower quality than the water quality standards are identified on state 303(d) lists (also known as "Lists of Impaired Waterbodies"). Third, a Total Maximum Daily Load (TMDL) is established for waters on the 303(d) list. Fourth, implementation plans are developed by the state to achieve the TMDL. Fifth, in some cases, a balance must be struck between the TMDL and the water quality standards. During implementation planning, it may become clear that there are no feasible improvement alternatives that will achieve the TMDL. In these cases, the TMDL and the water quality standards may have to be adjusted to achieve the highest levels of water quality that are feasible. Finally, the TMDL is implemented through the NPDES Permit Program, State Water Quality Standards Certification Program, the States Non-point Source Management Program and other appropriate mechanisms.

Often the TMDL and the implementation plan are developed together and there may even be iterative manipulation of the two until a workable mix is achieved. In the case of the main stems temperature TMDL, the two have been kept some what separated. Interest in temperature in the main stems peaked during development of the 2000 Federal Columbia River Power System (FCRPS) Biological Opinion by the National Marine Fisheries Service (NMFS) and the Fish and Wildlife Service (FWS). Many believed that elevated temperatures played a role in the reduction of salmon runs, while others believed that temperature in the main stems had not changed significantly from natural conditions. Further, the water quality standards do not establish a clear target for temperature and require considerable analysis. So it wasn't clear if there was a temperature problem, how severe it was or what was causing it. Implementation planning to improve water temperature could be very costly, especially for the federal and public utility district dams on the rivers. Therefore, it is prudent to verify that a problem exists and to quantify the extent of the problem before investing a great deal. Essentially, the role of this TMDL in improving temperature in the Columbia/Snake River main stems is to clarify these issues. The purpose of this TMDL is to:

1. define the temperature targets;
2. quantify the temperature problem on the main stems;
3. determine the level of improvement needed.

The TMDL, therefore, uses water quality modeling to determine the specific water temperature targets for the main stems on the basis of state water quality standards. The water quality standards require identification of what the temperatures would be in the absence of human activities on the main stems. Having determined the temperature regime required by the state water quality standards, the TMDL evaluates whether the existing main stems achieve those target temperature regimes and quantifies the contributions of existing human activities to temperature increases in the river. This TMDL finds that temperature does exceed the target temperature regimes required by state water quality standards so it goes on to quantify the improvement needed and allocate heat loads to the various human activities on the main stems that, if achieved, will result in compliance with the target temperatures.

The next step in improving temperature in the main stems is to develop the implementation plan. That is, determine what specific operational changes at the dams and point sources of heat along the rivers can be implemented to achieve the TMDL and ultimately achieve water quality standards. In other words, what feasible alternatives are available to improve temperature. The TMDL identifies some of the dams on the main stems to be the major contributors to temperature increases in the main stems. Implementation planning to achieve temperature improvements at dams will be technically complicated, costly and generally outside Clean Water Act authorities. The federal dams were specifically authorized by Congress for specific purposes such as flood control, power generation, irrigation and navigation. Decisions on the feasibility of alternatives to improve temperature at these facilities will have to consider the ability of the FCRPS to continue achieving the purposes established by Congress, the technical feasibility of the alternatives and the economic feasibility of the alternatives.

The states take the lead for TMDL implementation planning but they will rely heavily on the Federal Agencies that administer and operate the FCRPS. In fact, development of improvement alternatives will require a sytstem wide evaluation of the FCRPS and the Columbia/Snake River system. Improvements in temperature resulting from operation of the river system will rely heavily on regional, national and even international forums. Because of the complicated policy and technical issues incumbent on implementation planning, in this case, it could be a lengthy process.

However, that is not to say that the FCRPS has been inactive in planning and implementing measures to improve water temperature in the Columbia and Snake River main stems. The Bonneville Power Administration is financing sub-basin planning all over the Columbia Basin to improve salmon habitat, including temperature in the tributaries to the Columbia and Snake Rivers. The Corps of Engineers has operated Dworshak Dam for the last three years to discharge cooler water to improve temperature in the lower Snake River. Every year, the Corps works with EPA, NMFS and the states and tribes to refine and fine tune it's approach to operating the Dworshak Dam. Two major limitations on implementation planning have been the lack of data to adequately characterize water temperature and the lack of water quality modeling that can evaluate the effects of improvement alternatives at specific dams and site along the river. In 2002, the FCRPS agencies began an effort to address these limitations. Working with NMFS, FWS, EPA, the states and the tribes, the FCRPS agencies developed an interagency committee that is evaluating monitoring and modeling efforts on the rivers. That committee, chaired by the Corps and NMFS, will determine appropriate water quality models and the monitoring necessary to support those models. That committee has been very active and has resulted in intensive monitoring efforts in 2002, including monitoring of temperature in fish passage facilities. The Bureau of Reclamation has been active in working with EPA in development of the TMDL to ensure that there is an adequate understanding of the operation of Grand Coulee Dam and the Columbia Basin Irrigation Project and to brain storm improvement measures that can be evaluated to determine if they are feasible and will have a beneficial effect on water temperature downstream of Grand Coulee while not causing impairment of temperature upstream of the dam in Lake Roosevelt.

Continued cooperation of the federal agencies, the states and tribes will ensure that the implementation planning results in a balanced strategy that considers ecological needs above and below Grand Coulee, achievement of the Congressionally authorized purpose of the FCRPS and is technically feasible and economically achievable. Step 5 of the water quality improvement process is to alter the TMDL and the water quality standards, as appropriate, to strike this balance between competing ecological needs and competing uses and values of the river system. If it is not feasible to achieve the TMDL without sacrificing ecological needs upstream of Grand Coulee or the other uses of the river system, the water quality standards can be amended and the TMDL revised to achieve the new standards.

The EPA water quality standards regulations provide for situations where water quality standards cannot be attained. The regulations specifically address dams. At 40 CFR 131.10(g) the regulations say "States may remove a designated use which is not an existing use, as defined in Sec. 131.3, or establish sub-categories of a use if the state can demonstrate that attaining the designated use is not feasible because: ....(4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use." The regulations also address te concept of economic feasibility at 40 CFR 131.10(g)(6): "Controls more stringent than those required by sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact."

Sequentially, the final step in the improvement process is actual implementation of the measures to improve water quality. In actuality, implementation can occur simultaneously with the planning processes and in this case a great deal of work is being done to improve temperature in the Columbia and Snakes rivers as described above. The whole water quality improvement process outlined above, including the TMDL will be an iterative process. As the FCRPS agencies continue to work toward temperature improvements, develop water quality models and collect water quality data, the TMDL may updated.

1.2 Scope of this TMDL

The scope of this TMDL is water temperature in the main stem segments of the Columbia River from the Canadian Border (River Mile 745) to the Pacific Ocean and the Snake River from its confluence with the Salmon River (River Mile 188) to its confluence with the Columbia River (see Figure 1-1). Table 1-1 summarizes the portions of the two rivers listed as impaired for temperature pursuant to Section 303(d) of the Clean Water Act. EPA listed the Snake River from the Salmon River to the Washington/Idaho Border on the Idaho 1998 Section 303(d) list (EPA, 2001). Oregon included the entire Oregon portions of the Snake and Columbia rivers on its 1998 Section 303(d) list (Oregon DEQ, 1998). Washington included 26 different segments of the two rivers on its 1998 Section 303 list (Washington DOE, 1998). In a letter dated September 4, 2001, Washington clarified that "...much or all of the mainstem Columbia and Snake Rivers violate water quality standards for temperature..." and that the entire lengths of the Columbia and Snake rivers should be addressed in the temperature TMDL (Washington DOE, 2001). This TMDL addresses dams, point sources and non-point sources of thermal loading to the main stems themselves. There are 15 dams, as well as 106 point sources regulated by individual National Pollutant Discharge Elimination System (NPDES) permits, on the two main stems addressed by this TMDL. There are also 27 general NPDES permits that currently regulate 96 facilities on the Snake and Columbia rivers. The thermal loadings from non-point sources enter the main stems primarily through tributaries and irrigation return flows. There are 193 tributaries including seven significant irrigation flows addressed in this TMDL.

1.3 Legal Authority

Under authority of the Clean Water Act, 33 U.S.C. § 1251 et seq., as amended by the Water Quality Act of 1987, P.L. 100-4, the U.S. Environmental Protection Agency is establishing a Total Maximum Daily Load (TMDL) for temperature in the main stems of the Columbia River from the Canadian Border to the Pacific Ocean and the Snake River from its confluence with the Salmon River to its confluence with the Columbia River. EPA is establishing the TMDL for waters within the states of Washington and Oregon and waters within the reservations of the Confederated Tribes of the Colville Reservation and the Spokane Tribe of Indians. At this time, the Idaho Department of Environmental Quality is anticipating simultaneously issuing the TMDL for waters within the jurisdiction of the State of Idaho.

The States of Oregon, Washington and Idaho worked with EPA in coordination with the thirteen tribes of the Columbia Basin to develop this inter-jurisdictional TMDL for the Columbia and Snake River main stems. The Oregon Department of Environmental Quality requested in writing (Oregon DEQ, 2001) that EPA establish the TMDL in the State of Oregon. The Department cited the interstate nature of the waterway, EPA's development of the temperature model, RBM 10, and the Department's lack of resources as the reasons for its request. The request was made pursuant to Section X of the TMDL Memorandum of Agreement between EPA and the Department of Environmental Quality dated February 1, 2000.

Table 1-1: Section 303(d) Listings Addressed by this TMDL

Idaho:

HUC	Waterbody	Boundaries	Pollutant
17060103	Snake River	Salmon River to Washington State Line	Temperature

Oregon:

Basin	Waterbody	Boundaries	Pollutant
Lower Columbia	Columbia River	Mouth to Tenasillahe Island	Temperature
Lower Columbia	Columbia River	Tenasillahe Island to Willamette River	Temperature
Lower Columbia	Columbia River	Willamette River to Bonneville Dam	Temperature
Middle Columbia	Columbia River	Bonneville Dam to The Dalles Dam	Temperature
Middle Columbia	Columbia River	The Dalles Dam to John Day Dam	Temperature
Middle Columbia	Columbia River	John Day Dam to McNary Dam	Temperature
Middle Columbia	Columbia River	McNary Dam to Washington Border	Temperature
Middle Snake	Snake River	Washington Border to Hell's Canyon Dam	Temperature

Washington:

Water Resource Inventory Area Name	Number	Waterbody	Pollutant	Number of Segments
Grays-Elokoman	25	Columbia River	Temperature	3
Lewis	27	Columbia River	Temperature	2
Salmon-Washougal	28	Columbia River	Temperature	6
Klickitat	30	Columbia River	Temperature	3
Rock-Glade	31	Columbia River	Temperature	2
Moses Coulee	44	Columbia River	Temperature	1
Chelan	47	Columbia River	Temperature	1
Lower Snake	33	Snake River	Temperature	4
Snake River	35	Snake River	Temperature	4

Similarly, the Washington Department of Ecology requested by letter (Washington DOE, 2001) that EPA establish the Columbia/Snake Main Stem Temperature TMDL in Washington. The Department also cited the inter-jurisdictional nature of the waterways, EPA's work on the TMDL and the Departments lack of resources as the reasons for its request. The request was made pursuant to Section 13 of the TMDL Memorandum of Agreement between the Department of Ecology and EPA dated October 29, 1997.

EPA has authority under section 303(d)(2) of the Clean Water Act (CWA) to approve or disapprove TMDLs submitted by the states and tribes and to establish its own TMDLs in the event that it disapproves a state or tribal submission. EPA also has authority under section 303(d)(2) to establish TMDLs in response to an explicit state request. EPA's exercise of authority to establish TMDLs in response to a state's request is consistent with the larger purpose of section 303(d)(2) – to ensure the timely establishment of TMDLs – and it honors the primary responsibility imputed by Congress to the states. In addition, when the TMDL focuses on interstate waters, EPA's involvement can facilitate the resolution of complex cross-jurisdictional problems that might be difficult for an individual state, acting alone, to resolve. For similar reasons, EPA has authority to establish TMDLs on behalf of tribes that have not been authorized to establish TMDLs under section 518(e) of the CWA.

1.4 Coordination with States and Tribes

EPA invited consultation with 14 Sovereign Tribes of the Columbia River Basin in a February 11, 2002, letter from L. John Iani, EPA Region 10 Regional Administrator, to each Tribal chair. Copies were also provided to the Columbia River Inter-Tribal Fish Commission. The letter recognized Tribal rights and the federal government responsibility to tribal governments and offered to provide the Tribes and tribal staff an opportunity for meaningful involvement in EPA's final action on this TMDL effort. EPA offered to meet individually with Tribes on a government-to-government basis. In response to this invitation EPA has met with a number of the tribal governments. EPA has also been providing direct technical assistance to the Colville Confederated Tribes and the Spokane Tribe.

EPA has been requested by Tribal representatives to address historic preservation and to explain how cultural resources issues would be addressed by this TMDL. EPA is proposing in this preliminary draft that the State and Tribal Implementation plans address the National Historic Preservation Act. EPA will continue to coordinate and consult with the Tribes to integrate historic preservation and cultural concerns into actions stemming from this TMDL.

EPA signed a Memorandum of Agreement (MOA) with the states of Oregon, Idaho and Washington in August 2001. This MOA described the mutual relationship between the states and EPA Region 10 to complete a dissolved gas and temperature TMDL for the mainstem and Columbia and Snake Rivers. The MOA detailed the conceptual approach to the TMDL effort, the roles of the MOA signatories, expected roles of the cooperating agencies, resources, and schedule.

Beginning in February 2001 and continuing until present, EPA, states and tribal staff met on a monthly basis to plan the development of the temperature TMDL effort, agree on technical issues and plan outreach and coordination efforts. In 2001, Federal Action Agencies (U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration) and industry representatives were invited to participate in these monthly meetings as well.

2.0 Applicable Water Quality Standards

2.1 General

Three states and one Indian tribe have WQS standards promulgated pursuant to section 303(c) of the CWA that apply to the Columbia and Snake Rivers: Idaho, Oregon, Washington and the Confederated Tribes of the Colville Reservation. Another Indian tribe, the Spokane Tribe of Indians has WQS for the Columbia River that have been adopted by the tribe but not yet approved by EPA. The WQS for each state and tribe for the portions of the Columbia and Snake Rivers subject to this TMDL are summarized below:

2.2 Idaho

The WQS for Idaho are established in the Idaho Administrative Code, IDAPA 16.01.02, "Water Quality Standards and Wastewater Treatment Requirements." Section 130.02 establishes the designated aquatic life uses of the Snake River between the Salmon River and the Washington Border as cold water. Section 100.01.a defines cold water as "water quality appropriate for the protection and maintenance of a viable aquatic life community for cold water species." Section 250.02.b establishes the water quality criteria for temperature for the cold water aquatic life use designation as "Water temperature of twenty-two (22) °C or less with a maximum daily average of no greater than nineteen (19) °C."

Section 070.06 discusses natural background conditions: "Where natural background conditions from natural surface or groundwater sources exceed any applicable water quality criteria as determined by the Department, that background level shall become the applicable site-specific water quality criteria. Natural background means any physical, chemical, biological, or radiological condition existing in a water body due only to non-human sources. Natural background shall be established according to protocols established or approved by the Department consistent with 40 CFR 131.11. The Department may require additional or continuing monitoring of natural conditions."

2.3 Oregon

The WQS for Oregon are established in the Oregon Administrative Rules, OAR 340-041-0001 to OAR 340-041-00975, "State-Wide Water Quality Management Plan;

Beneficial Uses, Policies, Standards, and Treatment Criteria for Oregon." The Snake River in Oregon from the OR/WA Border at river mile 176 to the Salmon River at river mile 188 is included in this TMDL. The WQS for that portion of the river are included in the section for the Grande Ronde Basin (OAR 340-041-0722). The beneficial uses most sensitive to temperature in that reach are "Salmonid Fish Rearing" and "Salmonid Fish Spawning." The temperature criteria applicable to the reach are, in relevant part:

> "To accomplish the goals identified in OAR 340-041-0120(11), unless specifically allowed under a Department-approved surface water temperature management plan as required under OAR 340-41-026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed:
> (i) In a basin for which salmonid rearing is a designated beneficial use, and in which surface water temperatures exceed 64.0 °F (17.8 °C);
> (ii) In waters and periods of the year determined by the Department to support native salmonid spawning, egg incubation, and fry emergence from the egg and from the gravels in a basin which exceeds 55 °F (12.8 °C)....
> (vi) In stream segments containing federally list Threatened and Endangered species if the increase would impair the biological integrity of the Threatened and Endangered population;" (OAR 340-041-0725 (2)(b)(A).

The period of the year designated by the Oregon Department of Environmental Quality for the protection of salmonid spawning, egg incubation, and fry emergence in the Snake River is October 1 through June 30 (Oregon DEQ, 1998).

The numeric temperature criteria are established for the seven-day moving average of the daily maximum temperatures. If there is insufficient data to establish a seven-day average of maximum temperatures, the numeric criterion is applied as an instantaneous maximum (OAR 340-041-0006 (54)). A measurable surface water increase is defined as 0.25 °F (OAR 340-041-0006 (55)) . Anthropogenic is defined to mean that which results from human activity (OAR 340-041-0006 (56)).

The segment of the Columbia River which serves as the OR/WA border is included in this TMDL and subject to OR WQS. It stretches from the mouth of the river to river mile 309. The temperature sensitive beneficial uses vary from segment to segment along that reach as shown in Table 2-1.

Table 2-1: Oregon designated uses along the Columbia River

Basin/Columbia River Miles	Anadromous Fish Passage	Salmonid Fish Rearing	Salmonid Fish Spawning	Shad and Sturgeon Spawning/Rearing
Lower Columbia / 0-86	X	X		
Willamette / 86-120	X	X	X	
Sandy / 120-147	X	X		
Hood / 147-203	X	X	X	X
Deschutes /203-218	X	X		
John Day / 218-247	X	X	X	
Umatilla / 247-309	X	Trout	Trout	

The temperature criterion applicable to the Columbia River in Oregon is in relevant part:

"To accomplish the goals identified in OAR 340-041-0120(11), unless specifically allowed under a Department-approved surface water temperature management plan as required under OAR 340-41-026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed: ...

(ii) In the Columbia River or its associated sloughs and channels from the mouth to river mile 309 when surface water temperatures exceed 68.0 °F (20.0 °C)"
(iii) In waters and periods of the year determined by the Department to support native salmonid spawning, egg incubation, and fry emergence from the egg and from the gravels in a basin which exceeds 55 °F (12.8 °C)....
(vi) In stream segments containing federally list Threatened and Endangered species if the increase would impair the biological integrity of the Threatened and Endangered population;" (OAR 340-041-0205(2)(b)(A).

The period of the year designated by the Oregon Department of Environmental Quality for the protection of salmonid spawning, egg incubation, and fry emergence in the Snake River is October 1 through May 31 (Oregon DEQ, 1998).

Salmonid spawning occurs in the lower Columbia River upstream of river mile 112. Chum salmon are known to spawn around the Ives Island complex down stream of Bonneville Dam and in the vicinity of Interstate 205. They spawn in November and December and the eggs incubate until April. Lower river brights (Chinook) are also known to spawn in the Ives Island area starting about mid-October. Therefore, the water quality criteria for the lower Columbia are as follows:

- mouth to river mile 112
  all year - 20.0 °C

- river mile 112 to rm 309
  October 1- May 31 - 12.8 °C
  June 1 - September 30 - 20.0 °C

2.4 Washington

The WQS for Washington are established in the Washington Administrative Code, Chapter 173-201A WAC, "Water Quality Standards for Surface Waters of the State of Washington." Waters of the state are categorized in the Water Quality Standards into classes based on the character of the uses of each water body. The designated uses of the Columbia and Snake rivers most sensitive to temperature are salmonid migration, rearing, spawning and harvesting; and other fish migration, rearing, spawning and harvesting (WAC 173-201A-030). The most protected class on the Columbia and Snake rivers is "AA" or 'extraordinary' and this applies only to Lake Roosevelt. The rest of the river is grouped into class "A" or 'excellent' (WAC 173-201A-130). Under each of these classes, the temperature standard is applicable at any time of day or night. It applies toward fish protection in all portions of the rivers, including fish passage facilities and fish ladders within the dam structures.

Each class of water is assigned a daily maximum numeric temperature criterion. For class "AA" waters it is 16 °C and for class "A" waters it is 18 °C (WAC 173-201A-030). However, for the Columbia River below Priest Rapids dam and for the entire Snake River, a special condition applies which is two degrees higher, 20 °C (WAC 173-201A-130).

The Washington standards also include narrative requirements associated with natural conditions. "Natural Conditions" for temperature means water temperatures as they are best assessed to have existed before any human-caused pollution or alterations. If the Snake or Columbia Rivers are found to have a natural condition higher than the criterion, no additional temperature pollution can be added that will result in raising that natural temperature more than 0.3 °C. The wording of this portion of the standard indicates that the 0.3 °C increment is a constraint on the cumulative impact of all dischargers (WAC 173-201A-020).

There are also constraints on incremental temperature increases when existing temperatures are below the numeric criterion In some segments these allowable increases are expressed as formulas to be applied to individual sources, while in others the allowable increases are expressed as a maximum value not to be exceeded by cumulative impacts. The numeric temperature criteria and narratives establishing the allowable incremental temperature increases, applicable to the Snake and Columbia Rivers in Washington, are summarized in Table 2-2.

Table 2-2: **Washington Water Quality Standards along the Columbia and Snake Rivers**

Water Body	*Criteria*
Columbia Main Stem from the coast to the Oregon/Washington Border	"Temperature shall not exceed 20 °C (68 F) due to human activities. When natural conditions exceed 20 °C (68 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C (0.5 F) nor shall such temperature increases, at any time exceed 0.3 °C (0.5 F) due to a single source or 1.1 °C (2.0 F) due to all such activities combined." WAC 173-201A-130(20)
Columbia Main Stem Priest Rapids Dam to OR/WA Border	"Temperature shall not exceed 20 °C (68 F) due to human activities. When natural conditions exceed 20 °C (68 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C (0.5 F) nor shall such temperature increases, at any time exceed T=34/(T+9)." WAC 173-201A-130(21)
Columbia Main Stem Priest Rapids to Grand Coulee	"Temperature shall not exceed 18 °C (64.4 F) due to human activities. When natural conditions exceed 18 °C (64.4 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C (0.5 F). Incremental temperature increases resulting from point source activities shall not, at any time, exceed t=28/(T+7). Incremental increases resulting from nonpoint source activities shall not exceed 2.8 °C (5.4 F)." WAC 173-201A-130(21) and WAC 173-201A-030(2)
Columbia Main Stem Above Grand Coulee	"Temperature shall not exceed 16 °C (60.8 F) due to human activities. When natural conditions exceed 16 °C (60.8 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C (0.5 F). Incremental temperature increases resulting from point source activities shall not, at any time, exceed t=23/(T+5). Incremental increases resulting from nonpoint source activities shall not exceed 2.8 °C (5.4 F)." WAC 173-201A-130(22) and WAC 173-201A-030(1)
Snake Main Stem from the Washington/Oregon Border to the Clearwater River.	"Temperature shall not exceed 20 °C (68 F) due to human activities. When natural conditions exceed 20 °C (68 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C (0.5 F) nor shall such temperature increases, at any time exceed 0.3 °C (0.5 F) due to a single source or 1.1 °C (2.0 F) due to all such activities combined." WAC 173-201A-130(98)(b)
Snake Main Stem from the Clearwater River to the Columbia River.	"Temperature shall not exceed 20 °C (68 F) due to human activities. When natural conditions exceed 20 °C (68 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C (0.5 F) nor shall such temperature increases, at any time exceed t=34/(T+9)." WAC 173-201A-130(98)(a)

t = the maximum permissible temperature increase measured at a mixing zone boundary
T = the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

2.5 Confederated Tribes of the Colville Reservation

The WQS for the Confederated Tribes of the Colville Reservation were promulgated by EPA at 40 CFR 131.135. These standards apply to the Columbia River from the northern boundary of the reservation downstream to Wells Dam. The Columbia River is designated as "Class I (Extraordinary)" from the Northern Border of the Reservation to Chief Joseph Dam and "Class II (Excellent)" from Chief Joseph Dam to Wells Dam. The designated uses most sensitive to temperature are "Fish and shellfish: Salmonid migration, rearing, spawning and harvesting: other fish migration, rearing, spawning and harvesting." The temperature criterion for Class I waters is:

"(D) Temperature - shall not exceed 16.0 °C due to human activities. Temperature increases shall not, at any time, exceed t=23/(T+5).
(1) When natural conditions exceed 16.0 °C, no temperature increase will be allowed which will raise the receiving water by greater than 0.3 °C.
(2) For purposes hereof, "t" represents the permissive temperature change across the dilution zone: and "T" represents the highest existing temperature in this water classification outside of any dilution zone.
(3) Provided that temperature increase resulting from nonpoint source activities shall not exceed 2.8 °C, and the maximum water temperature shall not exceed 16.3 °C."

The temperature criterion for Class II waters is:

"Temperature - shall not exceed 18.0 °C due to human activities. Temperature increases shall not, at any time, exceed t=28/(T+7).
(1) When natural conditions exceed 18.0 °C, no temperature increase will be allowed which will raise the receiving water by greater than 0.3 °C.
(2) For purposes hereof, "t" represents the permissive temperature change across the dilution zone: and "T" represents the highest existing temperature in this water classification outside of any dilution zone.
(3) Provided that temperature increase resulting from nonpoint source activities shall not exceed 2.8 °C, and the maximum water temperature shall not exceed 18.3 °C."

2.6 The Applicable Water Quality Standards for this TMDL

The goal of this TMDL is to achieve all of the promulgated WQS for temperature in the Columbia and Snake River mainstems. Since the standards vary according to river location and jurisdiction, the development of the TMDL begins with a reach-by-reach review of overlapping state and tribal standards to determine the most stringent standard for each reach. Table 2.3 summarizes the most stringent water quality standards for the Columbia and Snake Rivers for purposes of this TMDL.

EPA believes it is reasonable to apply the most stringent temperature water quality standard for each reach because this is an interstate TMDL and the Columbia and Snake Rivers form borders between the affected states. This approach is the only way EPA has identified to ensure that all temperature water quality standards are met for the affected segments. Based on the record available to EPA at this time, EPA is concerned that developing a TMDL targeted at the less stringent temperature standards for a particular reach would not assure achievement of the more stringent standards also applicable to the reach, because it appears that temperature loadings delivered at the border by the state with the less stringent standards – i.e., the "background" loadings – would make it difficult, if not impossible, for the neighboring state to achieve its temperature water quality standards.

Moreover, as a legal matter, EPA is authorized to consider downstream water quality standards (including those in other states),when establishing or approving a TMDL. The U.S. Supreme Court in Arkansas v. Oklahoma, 503 U.S. 91 (1992), held that EPA has the authority to impose NPDES permit limitations and conditions based on downstream water standards. At issue in that case was EPA's issuance of an NPDES permit to an Arkansas facility that imposed conditions derived from the downstream state's water quality standards. (The court declined to address the issue of whether the statute required consideration of downstream standards because it found that EPA's assertion of authority was reasonable.) Noting that "the statute clearly does not limit the EPA's authority to mandate such compliance," the Court held, "The regulations relied on by the EPA were a perfectly reasonable exercise of the Agency's statutory discretion. The application of state water quality standards in the interstate context is wholly consistent with the Act's broad purpose 'to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.' 33 U.S.C. § 1251(a). Moreover, as noted above, § 301(b)(1)(C) expressly identifies the achievement of state water quality standards as one of the Act's central objectives. The Agency's regulations conditioning NPDES permits are a well-tailored means of achieving this goal." The regulations considered by the court, 40 C.F.R. § 122.4(d), provide, "No permit shall be issued . . . [w]hen the imposition of conditions cannot ensure compliance with the applicable water quality requirements of all affected States."

The principle articulated with the Supreme Court in the NPDES permitting context applies with equal force to TMDLs, which are an important tool for implementing section 301(b)(1)(C) with respect to point source discharges. Washington, Oregon and EPA, as the permitting authority in Idaho and for Tribal waters, are required to consider water quality standards in downstream segments (including those in other states) when establishing NPDES permit limitations and conditions for sources whose discharges ultimately flow to the downstream segments. See 40 C.F.R. § 122.4(d). For point sources discharging to waters flowing into the Columbia and Snake Rivers, those permit limitations need to be "consistent with" the assumptions of the TMDL for those rivers, irrespective of state boundaries. See 40 C.F.R. § 122.44(d)(1)(vii)(B). Therefore, in order to reconcile applicable permit regulations, it follows that EPA, when establishing a TMDL for upstream waters, may take into account the downstream water quality standards that would apply, under 40 C.F.R. § 122.4(d), to point source discharges covered by the TMDL. When a water forms a border, as here, each state is potentially downstream of the other for purposes of EPA's regulations.

Table 2-3: **Summary of Water Quality Standards that Apply to the Columbia and Snake Rivers**

Columbia River Reach	**Criterion**	**Natural Temp < Criterion**	**Natural Temp > Criterion**
Canadian Border to Grand Coulee Dam	16 °C DM	Natural + 23/(T+5)	Natural + 0.3 °C
Grand Coulee Dam to Chief Joseph Dam	16 °C DM	Natural + 23/(T+5)	Natural + 0.3 °C
Chief Joseph Dam to Priest Rapids Dam	18 °C DM	Natural + 28/(T+7)	Natural + 0.3 °C
Priest Rapids Dam to Oregon Border	20 °C DM	Natural + 34/(T+9)	Natural + 0.3 °C
Oregon Border to mouth	12.8/20 °C DM	Natural + 1.1 °C	Natural + 0.14°C
Snake River Reach	**Criterion**	**Natural Temp < Criterion**	**Natural Temp > Criterion**
Salmon River to OR/WA Border	12.8/17.8 °C 7DADM	Up to Criterion	Natural + 0.14 °C
OR/WA Border to ID/WA Border	20 °C DM	Natural + 1.1 °C	Natural + 0.3 °C
ID/WA Border to Mouth	20 °C DM	Natural + 34/(T+9)	Natural + 0.3 °C

T = the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.
DM = daily maximum temperature.
7DADM = seven day average of the daily maximum temperatures.

2.7 Antidegradation

All four jurisdictions contain an antidegradation policy in their WQS. Generally, the antidegradation policies apply to waters that are of a higher quality than the water quality criteria. In these waters the existing water quality must be protected and pollution that would reduce the existing water quality is not allowed. All four jurisdictions do provide exceptions to this policy when certain conditions apply. The antidegradation provisions are important to this TMDL because much of the year, the temperature of the main stems is below the numeric criteria.

2.8 Mixing Zones

All four jurisdictions have mixing zone provisions in their WQS. The Colville standards refer to them as dilution zones. Mixing and dilution zones are the areas in the vicinity of point source outfalls where mixing results in the dilution of the effluent with the receiving water. Water quality criteria may be exceeded in the mixing or dilution zone. All four jurisdictions have restrictions on the size and characteristics of mixing or dilution zones.

3.0 Technical Considerations

3.1 Mathematical Modeling

The WQS that apply to the Columbia River require derivation of the specific target temperatures for the TMDL based on natural temperatures in the river (see Table 2-3). Natural temperature is considered to be the water temperature that would exist in the river in the absence of any human-caused pollution or alterations. This definition applies to all human activities: those that effect the river temperature directly such as point sources of warm water or dams and impoundments; and those that effect river temperature indirectly such as development in the water shed and air pollution that results in climate change.

The Columbia River was first dammed in 1933 and the Snake River, its principle tributary was first dammed in the 19th century. Since the 19th century the number of dams in the TMDL study area has grown to 15, and the watershed has been extensively developed for forestry, agriculture, mining and domestic and industrial uses. Such human activities in the watershed of a river generally lead to altered water temperatures in the river. There is little temperature data available for the free flowing Columbia and Snake rivers that would reflect natural temperature prior to the advent of these human sources of thermal energy in the watershed. Therefore, it is necessary to use a mathematical model to simulate natural temperatures in order to derive the specific temperature targets for the TMDL.

RBM 10, a one dimensional, energy budget mathematical model, was developed to simulate temperature in the Columbia River (Yearsley, 2001). It simulates daily cross sectional average temperatures under conditions of gradually varied flow. Models of this type have been used to assess water temperature in the Columbia River system for a number of important environmental analyses. The Federal Water Pollution Control Administration (Yearsley, 1969) developed and applied a one-dimensional thermal energy budget model to the Columbia River as part of the Columbia River Thermal Effects Study. The Bonneville Power Administration et al. (1994) used HEC-5Q, a one dimensional water quality model, to provide the temperature assessment for the System Operation Review, and Normandeau Associates (1999) used a one-dimensional model to assess water quality conditions in the Lower Snake River for the U.S. Army Corps of Engineers. RBM 10 was used by the Corps of Engineers for the temperature assessment in the "Lower Snake River Juvenile Salmon Migration Feasibility Report and Environmental Impact Statement" (Corps, 2002).

RBM 10 requires information on the river system and weather. Necessary river system information includes topology, geometry (cross-sectional area and width), mainstem inflows and temperatures at the model boundaries, and tributary and point source flows and temperatures. In order to simulate temperature in the absence of human intervention, geometry information is needed for the original, free flowing river. Necessary weather information is cloud cover, dry bulb air temperature; wind speed, vapor pressure of the air and atmospheric pressure. A thirty year data record consisting of the needed weather and flow information was constructed for the period from 1970 through 1999. Stream geometry for the un-impounded and existing river was compiled from the Columbia River Thermal Effects Study (Yearsley, 1969), information from the Walla Walla District, U.S. Army Corps of Engineers and from NOAA navigation charts (Yearsley, 2001). Using this record, thirty years of river temperatures were simulated for both Columbia and Snake rivers under impounded and free flowing conditions. To simulate free flowing conditions, the dams and point sources are mathematically removed in order to approximate natural temperature conditions within the TMDL study area. In the remainder of this report, simulations of impounded conditions are often referred to as "the impounded river" while simulations of free flowing conditions are referred to as the "free flowing" or "site potential" river.

3.2 Site Potential Temperature

This simulation strategy provides the cross-sectional average temperatures that would occur in the Columbia and Snake rivers within the TMDL study area in the absence of human activity within the main stem of the rivers. These temperatures are referred to in the TMDL as site potential temperatures. As the name implies, they are the temperatures that could occur in the Columbia and Snake rivers within the TMDL study area if the influence of human activity in the main stems on water temperature is eliminated. But the human influence outside the TMDL study area still remains. The inputs to the model; main stem temperature and flow, tributary temperature and flow and weather are not natural conditions. Flows in the main stem and the tributaries have been permanently altered by the construction of dams irrigation withdrawals and other consumptive uses. So the term site potential is used to indicate that the simulations do not recreate the water temperatures that preceded European influence in North America. The modeling effort, by removing the impacts of all human activity from within the main-stems themselves, is a reasonable approach to use to assess natural temperature conditions

There is one exception to the use of actual conditions at the boundaries of the TMDL. Dworshak Dam on the North Fork of the Clearwater River can be operated so as to discharge deep, colder water from its reservoir as a means of improving flow and temperature conditions downstream in the Snake River to aid in the recovery of endangered salmon. Though Dworshak Dam has always released colder water into the Clearwater River, it has been operated to aid salmon recovery, to varying degrees since 1991. The 2000 Biological Opinion on operation of the Federal Columbia River Power System contains a Reasonable and Prudent Alternative (RPA 19) calling for the management of Dworshak discharge to attempt to maintain water temperatures at the Lower Granite Reservoir forebay dissolved gas monitoring station at or below 20 °C. Since these Dworshak releases are not standard operating procedure at Dworshak but are instead part of implementation efforts for restoring temperatures in the river they are not included in the simulations of site potential temperature. Clearwater Rivers flows and temperatures in the model have been adjusted to eliminate those additional releases from the Dworshak Dam from 1991 through 1999 that were intended for salmon and water quality recovery in the lower Snake River.

The Northwest Power Planing Council's Independent Science Group in their report "Return to the River" note the need to study the effect of unnaturally cold reaches of the Snake and Clearwater Rivers (below Hells Canyon and Dworshak Dams respectively) on fall Chinook (ISG, 2000). That the Clearwater River is cooler in the summer than it was prior to 1972 when Dworshak Reservoir began storing water is shown by USGS water temperature records at the Peck gage which date back to 1967[1]. Also, as is typical of regulated rivers, summer flows are greater now than for the previously un-impounded river. This has made the Clearwater River a source of anthropogenic cooling, not warming, to the lower Snake River. This effect has been manipulated since 1991 to increase coldwater releases specifically to further cool the lower Snake River so as to aid salmon passage. A similar but not so dramatic summer cooling effect is also evident in the Snake River due to Brownlee Reservoir. Although Snake River flows have also been augmented since 1991 to aid salmon passage (aka the 'salmon flush') these flows have not specifically been targeted toward temperature management. Furthermore, while the Snake River downstream of Hells Canyon appears to be cooler in summer, it also appears to be warmer in the fall than would be the un-impounded river.

Figure 3-1 illustrates the site potential temperature and the impounded temperature during 1977 at John Day Dam as simulated by the RBM10 model. The figure illustrates the typical differences between the site potential or free flowing river and the existing impounded river. The free flowing river tends to cool faster in the fall and winter. Temperature in the free flowing river also tends to vary more in response to changes in air temperature. Water temperature is not constant throughout the year. Neither is it constant from year to year or along the length of the river. There are warm years and cool years and the water temperature changes as the water moves downstream. The estimates of site potential and ultimately the TMDL target temperatures have to account for that variation.

The longitudinal variability is captured by dividing the river into a series of reaches and estimating the site potential at a target site in each reach. In this TMDL, 21 reaches are designated. See Section 5.0 for a complete discussion of the establishment of target sites for the TMDL. The year to year variability in site potential temperature was captured by simulating 30 years of site potential temperatures and computing the mean site potential temperature for every day of the year. Figure 3-2 illustrates the variability of site potential temperatures and the mean site potential at John Day Dam as simulated by RBM10. The 30 year mean site potential temperatures for every day of the year form the basis for this TMDL and the target temperatures that the TMDL is intended to achieve are expressed as 30 year means for every day of the year (see section 5). This is a reasonable approach for developing a TMDL when the target temperatures can fluctuate. When the TMDL is successfully implemented, water temperature during specific years will be warmer or cooler than the target temperature (a 30 year mean)

---

[1] Water temperature data are available for the USGS gage on the Clearwater River @ Peck, a few miles below the confluence of the North Fork Clearwater, for 1967 to present, pre-dating Dworshak Dam on the North Fork by 5 years. More recent USGS data - from the NF Clearwater above Dworshak Reservoir, the main Clearwater @ Orofino (just above the NF confluence), and an additional downstream site on the Clearwater @ Spalding - show the cooling that operation of Dworshak Dam has had on the lower Clearwater River.

because of the natural variability that occurs, but the long term mean temperatures should closely approximate the target temperatures. In Figure 3-2, the black curve labeled "IMP" represents the 30 year mean temperature under the existing impounded river conditions. The difference between the white site potential curve and the back impounded curve shows the improvement in long term mean water temperature called for by the TMDL at John Day Dam.

3.3 Implications of Using Daily Cross Sectional Average Temperature Simulations

The site potential temperatures which form the basis for the target temperatures in this TMDL are based on simulations of daily cross sectional average temperature. The water quality standards of the 3 states and tribe for temperature include numeric criteria written in terms of maximum temperature or seven day average of daily maximum temperatures. However, the standards do allow temperature to exceed natural (site potential) temperature by small incremental amounts when the natural temperatures exceed numeric criteria (see Table 2-3). None of the applicable standards specify the units in which the natural temperatures are to be expressed. It would be reasonable, to use the same units that are utilized for the numeric criteria. However, as discussed below, due to the relationship which exists between daily average and daily maximum temperatures in the Columbia and lower Snake Rivers, it is also reasonable to utilize simulations of the daily average temperature as a surrogate for daily maximum temperatures in this TMDL.

~~through site potential,~~

Considering the temporal and spatial variation of temperature in the free flowing and impounded rivers, the daily cross sectional average temperature is appropriate to use in the TMDL for the following reasons.

- The free flowing river was well mixed and achieved the cross section average temperature in most of the water body.
- Daily cross sectional average temperature exhibits the same patterns of seasonal fluctuation as daily maximum temperature.
- The daily maximum temperature can be less protective than the daily average temperature due to the manner in which dams effect water temperature.
- Analysis indicates that attainment of the daily average site potential temperature will also lead to attainment of the daily maximum site potential temperature.

The un-impounded or free flowing Columbia and Snake rivers were generally well mixed. Some temperature variation likely occurred in very shallow areas, around rocky protuberances and in static back waters because such areas warm faster toward equilibrium temperatures no matter what the thalweg temperature. Also, localized cool areas likely existed where groundwater or hyporheic up-welling occurred. But mixing would have occurred within the thalweg because of the rapid flow, intermittent rapids and water falls and diverse variety of instream channel features. Thus, the simulated cross sectional average temperature of the free flowing river is a good representation of the site potential temperature of the water body.

The TMDL target temperatures are daily cross sectional averages but, as in the free flowing river they are to be achieved througout the main river flow or thalweg. The TMDL would neither comply with water quality standards nor be protective of coldwater fish if it allowed two or three degree or greater temperature increases in the surface waters above natural. There will be places in the river warmer than the target temperatures, such as right against the face of the dams or in shallow stagnant backwaters or along rocky protuberances. But away from such conditions the bulk of the thalweg, critical salmon habitat, fish ladders and fish holding facilities are to meet the target temperatures.

Simulations of hourly average temperature using the RBM 10 model were run to determine daily maximum temperatures in the rivers under free flowing and impounded conditions. The highest hourly average temperature each day approximates the daily maximum temperature. Figure 3-3 compares simulations of hourly average and daily average temperature during 1997 at Lower Granite Dam. The figure demonstrates that the two measures of temperature, daily average and daily maximum exhibit the same seasonal variations.

Water temperature can vary throughout the day with changing air temperature and solar radiation. Simulations of hourly average temperature using the RBM 10 model demonstrate that the diel variation in the free flowing or site potential river is generally greater than in the impounded river. Figures 3-4 , 3-5 and 3-6 demonstrate this point using temperature simulations at Grand Coulee, Lower Granite and Bonneville dams during 1992. Notice at Grand Coulee Dam, diurnal fluctuation is almost nonexistent in the impounded river while the free flowing river temperature varies as much as 1.5 ° C during the day. At Lower Granite Dam the impounded river fluctuated about a half a degree but the free flowing river fluctuated 1.5 ° C or more. At Bonneville the daily fluctuation in the free flowing river is about 3 times greater than in the impounded river. We simulated the hourly average temperature at five dams for two years to compare the daily temperature fluctuation in the impounded and free flowing rivers. We compared the daily fluctuation in temperature at the five dams for the two years. Table 3-1 summarizes the results.

Table 3-1 shows the mean fluctuation in temperature during the day along with the smallest and largest daily fluctuations that occurred. Note that at all five dams during both years the greatest fluctuation in temperature occurred in the free flowing river. Lower Granite Dam during 1997 is the only data set that was at all ambiguous, with the daily fluctuation being very similar in the impounded and free flowing rivers. However, 1997 was an unusually high flow year. The flow rate through the river system was so fast that the initial temperature conditions at the model boundary, rather than heat exchange during the day, drove the temperature during the day. But even that year, the daily temperature fluctuation of the impounded river was generally within the daily fluctuation of the free flowing river.

Since the impounded river temperature fluctuates less during the day, establishing the TMDL at the daily maximum temperature could be less protective than called for by the water quality standards. Consider Figure 3-6. If the TMDL is established to achieve daily maximum site potential temperatures in the impounded river, the water temperature at Bonneville Dam

Table 3-1: Comparison of Daily Temperature Fluctuation of the Columbia and Snake Rivers Under Impounded and Free Flowing Conditions.

	Grand Coulee 1997		Priest Rapids 1997		Bonneville 1997	
	Impounded	Free Flowing	Impounded	Free Flowing	Impounded	Free Flowing
Mean	0.203	0.563	0.428	0.616	0.509	0.749
Standard Deviation	0.164	0.347	0.250	0.321	0.330	0.391
Minimum	0.000	0.113	0.016	0.069	0.063	0.110
Maximum	0.898	2.379	1.284	2.372	1.591	1.981
	Grand Coulee 1992		**Priest Rapids 1992**		**Bonneville 1992**	
	Impounded	Free Flowing	Impounded	Free Flowing	Impounded	Free Flowing
Mean	0.160	0.886	0.386	0.697	0.320	0.950
Standard Deviation	0.143	0.483	0.246	0.390	0.188	0.468
Minimum	0.000	0.116	0.039	0.011	0.045	0.148
Maximum	0.820	3.658	1.377	2.448	1.186	2.584

	Lower Granite 1997		Ice Harbor 1997	
	Impounded	Free Flowing	Impounded	Free Flowing
Mean	0.580	0.787	0.461	0.841
Standard Deviation	0.428	0.415	0.338	0.414
Minimum	0.049	0.156	0.039	0.131
Maximum	3.132	3.437	2.656	3.144
	Lower Granite 1992		**Ice Harbor 1992**	
	Impounded	Free Flowing	Impounded	Free Flowing
Mean	0.558	1.129	0.278	1.234
Standard Deviation	0.469	0.602	0.263	0.814
Minimum	0.035	0.165	0.018	0.157
Maximum	2.458	3.425	1.643	4.156

would be equal to the site potential or natural temperature at the hottest point of the day but during the night, temperature would be as much as 1.5 °C warmer than the site potential temperature. Under this scenario the river at Bonneville Dam would be under-protected because it would carry a heat load during the 24 hour day higher than the site potential river. If the TMDL is established to achieve the daily average temperature, the river won't achieve the coolest temperatures during the night but neither will it reach the hottest day time temperature and its overall heat load during the 24 hour period will be similar to that of the free flowing river. So establishing the TMDL to achieve the daily average temperature will allow less heat load during the day and be more protective. Therefore, the daily average temperature is a more appropriate measure to ensure that human activity does not cause the temperature to exceed site potential temperature.

it still exceeds it at night...

Since the impounded river temperature fluctuates less during the day than the free flowing river, attainment of the daily average site potential temperature will lead to attainment of the daily maximum site potential temperature as well. Consider an example in which the site potential daily average temperature is 20 °C with a temperature fluctuation during the day of 1.5 °C and the impounded river has a daily fluctuation 0.5 °. If the impounded river achieves the daily average of 20 °C it will stay within the daily maximum of 20.75 °C. However the reverse is not true. If the impounded river is brought into compliance with the daily maximum of 20.75 °C, its daily average will be around 20.5 °C, above the daily average site potential temperature. Again, the daily average site potential temperature is a more appropriate basis for the target temperatures for this TMDL.

The last concern about daily averaging is the possibility that there are days in which the daily maximum site potential temperature exceeds the criteria but the daily average does not. If this were to happen we would be setting target temperatures on the basis of site potential being less than criteria instead of greater than criteria. Examination of RBM 10 simulations of hourly average temperatures indicate that if this happens at all it is normally 1 day at the beginning of the time period when criteria are exceeded and 1 day at the end. The number of days could increase if the site potential temperature repeatedly exceeded then dipped below criteria throughout the warm period but since we are using 30 year average temperatures this never happens.

Summary

- WQS have criteria based on daily maximum temperatures.
- The standards themselves allow temperature to exceed natural (site potential) temperature by small incremental amounts and do not specify the units of measure for natural temperature.
- The target temperature applies throughout the width and depth of the river and in critical salmon habitat and holding areas.
- Daily average and daily maximum temperatures exhibit the same seasonal patterns.
- Using daily maximum site potential temperature to establish target temperatures could result in under-protecting temperature during much of the day.
- Attainment of the daily average site potential temperature will lead to attainment of

the daily maximum site potential temperature as well

- Using daily average site potential to determine if criteria are exceeded might underestimate days of exceedance by 1 day at the beginning of the warm period and one day at the end, but using the thirty year average period makes this insignificant.
- Throughout this report, temperature simulations and references to water temperature refer to daily cross sectional average temperatures unless otherwise noted.

4.0 Current Temperature Conditions

4.1 General

Temperature conditions in the Columbia and Snake river main stems are discussed in detail in Appendix A, "Problem Assessment for the Columbia/Snake River Temperature TMDL" (Problem Assessment). The Problem Assessment uses both existing temperature data and mathematical modeling of temperature to describe the existing temperature regime of the impounded river and the site potential temperature regime of the un-impounded or free flowing river.

Both the temperature observations and the temperature simulations provide estimates of water temperature. Since there are information gaps and uncertainties associated with both the observations and the simulations, both are used to gain an understanding of the free flowing and impounded temperature regimes and the relative importance of dams, point sources and tributaries in altering the natural regime of the rivers.

There is a considerable record of temperature data from the Columbia and Snake Rivers. McKenzie and Laenen (1998) assembled temperature data from 84 stations along the two rivers within the study area of this TMDL. However, the extensive data base from along the rivers must be used with caution. Little, if any of the data were collected with the express objective of evaluating temperature in the river. Few of the sampling sites have quality assurance objectives or followed quality control plans. Temperature measured at the same time at one dam can vary quite a bit depending on whether it was measured in the fore bay, the tail race or the scroll case. In using these data it is important to compare like stations along the river (e.g. scroll case to scroll case, fore bay to fore bay) and to use long records or repetitive examples when drawing general conclusions about temperature trends.

The RBM10 temperature model was developed ~~in part~~ to augment the understanding of temperature in the river derived from analysis of the data record. There is a good deal of information available for development of the temperature model. For example there are 30 years of continuous weather, flow and water temperature data. However, there are also modeling challenges that cause uncertainty in the modeling results. For example there is little information on temperature in the free flowing river to compare with simulated temperatures. Therefore, the problem assessment relies heavily on both data analysis and modeling analysis.

The analysis in the Problem Assessment provides the following information about the natural and existing temperature regimes of the river:

- The temperatures of the Columbia and Snake rivers frequently exceed state and tribal numeric water quality criteria for temperature during the summer months throughout the area covered by this TMDL.

- The water temperatures of the rivers before construction of the dams could get quite warm, at times exceeding the 20 °C temperature criteria of Oregon and Washington on the lower Columbia River.

- However, these warm temperatures were much less frequent without the dams in place. Temperature observations show that the frequency of exceedances at Bonneville Dam of 20 °C increased from about 3% when Bonneville was the only dam on the lower river to 13% with all the dams in place.

- The dams appear to be a major cause of warming of the temperature regimes of the rivers. Model simulations using the existing temperatures of tributaries and holding tributary temperatures to 16 °C revealed little difference in the frequency of excursion of 20 °C.

- Climate change may play a role in warming the temperature regime of the Columbia River. The Fraser River, with no dams, shows an increasing trend in average summer time temperature of 0.012 °C/year since 1941, 0.022 °C/year since 1953.

- The average water temperatures of the free flowing river exhibited greater diurnal fluctuations than the impounded river.

- The free flowing river average water temperature fluctuated in response to meteorology more than the impounded river. Cooling weather patterns tended to cool the free flowing river but have little effect on the average temperature of the impounded river.

- The free flowing river water temperatures cooled more quickly in the late summer and fall.

- Alluvial flood plains scattered along the rivers moderated water temperatures, at least locally, and provided cool water refugia along the length of the rivers.

- The existing river can experience temperature gradients in the reservoirs in which the shallow waters are warmer.

- Fish ladders, which provide the only route of passage for adult salmon around the dams, can become warmer than the surrounding river water.

4.2 Relative Impact of Dams, Tributaries and Point Sources on Temperature in the Columbia and Snake Rivers.

Point and non-point sources affect water temperature by directly adding warm water to the main stems. There are 106 point sources with individual NPDES permits that directly discharge to the mainstems evaluated in this TMDL. There are currently 96 point sources with General NPDES permits. Non-point sources tend to discharge to small streams and rivers in the watershed which eventually empty into the mainstems. There are 193 tributaries to the two main stems, including 7 significant irrigation return flows. Dams affect water temperature not by adding warm water to the system, but by altering the river flow, geometry and velocity upstream of the dam. This section discusses and compares the impacts from each of these kinds of heat sources.

Advected Sources of Heat - Tributaries and Point Sources

The impact of advected sources of heat such as tributaries and point sources on the cross-sectional average temperature of the main stem Columbia and Snake Rivers is determined by the ratio of advected energy from the source to the advected energy of the main stems. Mathematically, the new main stem temperature resulting from complete mixing with a tributary or point source is expressed as:

Equation 4.1:

$$T_{new} = [(V_{main\ stem} * T_{main\ stem}) + (V_{source} * T_{source})] / (V_{main\ stem} + V_{source})$$

T = temperature
V = volume

The Columbia and Snake Rivers are both quite large. The 7Q10 low flow of the Columbia ranges from 45,400 CFS at Grand Coulee Dam to 93,652 below Longview, WA. The 7Q10 low flow of the lower Snake is 14,500 CFS. Both rivers can accept a large advected thermal load without measurably increasing their temperature. For example, the largest/hottest point source in the Columbia River has a maximum discharge of 117 CFS and a maximum temperature of 39 °C. When mixed with the Columbia River at its 7Q10 low flow and 20 °C, it raises the average temperature of the Columbia by 0.02 °C. The largest discharger on the Snake River has a maximum flow of 62 CFS and a maximum temperature of 34 °C. When mixed with the Snake River at a 7Q10 low flow of 14,500 cfs and 20 °C, it raises the temperature of the Snake by 0.06 °C. ~~The~~ point source discharges to the Columbia and Snake rivers do not measurably increase the cross-sectional average temperature of the rivers.

Therefore, Individual

RBM 10 was used to further evaluate the cumulative effects of point sources on water temperature in the Columbia and Snake Rivers. Water temperature in the river was simulated with all the point sources in place and with all the point sources removed. Permit limits, or in the absence of permit limits, reasonable worst case temperature and flow rates were used for the point sources with do we have a basis for this?

individual NPDES permits. In order to account for point sources discharging under general NPDES permits 20 MW of heat energy was added at each TMDL target site. The target sites are explained in Section 5.2. Actual flow and weather data from 1970 through 1999 were used for simulating the river water temperature. Figures 4-1 and 4-2 plot the increase in temperature due to the presence of the point sources in the river throughout the thirty year period at river mile 42 in the Columbia River. Figure 4-1 shows all the data for the thirty year period. Figure 4-2 shows the data for times during which the river water temperature exceeded the 20 °C criterion. River mile 42 was selected as an example plot because it is the location where the increase due to point sources is greatest. Recall from Table 2-3 that the water quality standard for this stretch of river is natural temperature + 1.1 °C when natural is less than 20 °C, and natural + 0.14 °C when natural is above 20 °C. Note from Figure 4-1 that the increase due to point sources never approaches the 1.1 °C allowed by water quality standards when site potential is below the criterion. When site potential is above the criterion, temperature approaches but never exceeds the 0.14 °C increase allowed by the water quality standards (Figure 4-2). At most sites in the river, the impact of the point sources on water temperature was much less than shown here. At Wanapum, for example, the impact never exceeded 0.031 °C throughout the 30 years. The effect of point sources on water temperature is very small and, in and of themselves, the point sources do not lead to exceedances of water quality standards when averaged in with the total flow of the river.

But the discharges do cause near-field temperature plumes that can exceed temperature standards. Even when the discharge causes no measurable increase in cross-sectional average temperature, the temperature plume could be significant with respect to aquatic life habitat if left uncontrolled. The state and tribal WQS contain provisions to regulate the size and impact of these plumes.

Like the point sources, most of the tributaries have negligible effects on the cross sectional average temperature of the main stems. To illustrate this, Table 4-1 lists a number of the major tributaries to the Columbia and Snake rivers, their average flows, the average flows of the Columbia and Snake and the temperature difference between the tributary and the main stem that would be required to increase main stem temperature by 0.5 °C and 0.14 °C at those flow ratios. Note that only the Spokane, Snake and Willamette Rivers are large enough to potentially alter the temperature of the Columbia River by a measurable amount (0.14 °C). Only the Salmon, Grande Ronde and Clearwater Rivers are large enough to potentially alter the temperature of the Snake River by a measurable amount (0.14 °C)

Table 4-1 Effects of Specified Tributaries on Columbia and Snake River Temperature.

Tributary	Average Flow (CFS)	Columbia Average Flow (CFS)	ΔT (°C) to raise Columbia Temperature	
			0.5 °C	0.14°C
Spokane River	7,812	~ 100,000	7.0	1.9
Okanagan River	3,145	~106,255	17.0	4.9
Yakima River	3,569	~118,400	17.0	4.8
Snake River	55,090	~118,400	1.6	0.44
Deschutes	5,839	~185,161	16.0	4.6
Willamette	34,205	~191,000	3.2	0.92
		Snake Average Flow (CFS)	**ΔT (°C) to raise Snake Temperature**	
			0.5 °C	**0.14°C**
Salmon	11240	~23560	1.5	0.43
Grande Ronde	3101	~34800	6.0	1.7
Clearwater	15430	~37901	1.5	0.48

One way to evaluate and compare temperature conditions is to enumerate the number of days in a year, or the frequency, that a specified temperature is exceeded. In order to determine the importance of tributaries to the main stems' temperature regimes, the RBM10 model was used to compare the frequency with which temperature exceeds 20 °C in the main stems under existing conditions with the frequency of exceedances of 20 °C in the main stems if the tributaries never exceed 16 °C. That is, in the first simulation, actual tributary temperatures were used. In the second simulation, the tributary temperatures were not allowed to exceed 16 °C. Figures 4-3 and 4-4 illustrate the results. The effect of restraining tributaries to 16 °C is very small in the Columbia upstream of its confluence with the Snake. The combined average annual flows of advected sources in this segment are less than 10 percent of the average annual flow of the Columbia River at Grand Coulee Dam. Downstream of the Snake River (River Mile 326) there is a small effect. The Snake River was not constrained to 16 °C, but the reductions in Snake tributary temperatures, particularly, the Salmon and Clearwater rivers resulted in slightly less frequency of exceedances in the lower Columbia. On the Snake River, holding the Salmon and Clearwater rivers to 16 °C clearly effected the frequency. But the other tributaries have little effect so that at the mouth of the Snake River, the frequency of exceedances in the Snake was similar to the existing condition.

Dams as Sources of Heat

Model simulation results in ...

Figure 3-1 illustrates the effect that dams have on temperature in the main stem. Note that the impounded and free flowing rivers warm up at approximately the same rate in the spring.

However, the free flowing river cools off in the late summer and fall faster than the impounded river. At John Day Dam, on average, the impounded river temperature returned below 20 °C three weeks after the site potential river. In the early fall, on average, the free flowing river was as much as 3.5 degrees cooler. In short, dams effect water temperature in the main stem by adding to the length of time that temperature exceeds the numeric criterion, and by causing the river to be warmer during the late summer and fall.

To determine the effect of each individual dam on water temperature, the RBM 10 model was used to determine what the water temperature would be if the individual dams were removed one at a time. The results for all the dams are depicted graphically in Appendix F. Table 4-2 shows the maximum temperature increase caused by each dam. Note that the dams as a group very widely in their effects on temperature. In fact, there appear to be three fairly distinct groups of dams based on their temperature effects. First, there is a group of six dams that clearly increase temperature by more than a degree centigrade and up to as much as 6 °C. These six dams are Grand Coulee, John Day, Lower Granite, Little Goose, Lower Monumental and Ice Harbor. Second, there is a group of two dams that have highly variable impacts on temperature up to a degree centigrade. These are Chief Joseph and Wanapum. Finally, there is a group of seven dams with highly variable impacts ranging from no impact to a maximum impact of 0.5 °C. These dams are Wells, Rocky Reach, Rock Island, Priest Rapids, McNary, The Dalles and Bonneville. Rocky Reach and Rock Island do not have a measurable effect (>0.14°C) on temperature. At Wells, Rocky Reach and Rock Island the temperature effect is so small and so variable that they actually have a cooling effect on the river on the average. The Dalles has a warming effect but it is less than measurable all except one day of the year.

Table 4-2: Each dam's maximum effect on temperature at that dam site.

Facility	Maximum Impact	Facility	Maximum Impact
Grand Coulee	6.23 °C	John Day	1.39 °C
Chief Joseph	0.69 °C	The Dalles	0.147 °C
Wells	0.22 °C	Bonneville	0.27 °C
Rocky Reach	0.13 °C	Lower Granite	2.08 °C
Rock Island	0.07 °C	Little Goose	2.18 °C
Wanapum	0.86 °C	Lower Monumental	1.31 °C
Priest Rapids	0.28 °C	Ice Harbor	1.20 °C
McNary	0.36 °C		

4.3 Summary

The effects of the tributaries and point sources on cross sectional average water temperatures in the main stems are for the most part quite small. The exceptions are the major tributaries: Spokane River, Snake River and Willamette River on the Columbia and Salmon River and Clearwater River on the Snake. The point sources can cause temperature plumes in the near-field but they do not result in measurable increases to the cross-sectional average temperature of the main stems. Three of the dams, like the point sources, cause no measurable increase in cross sectional average temperature. Some of the dams, however do alter the cross-sectional average temperature of the main stems and they extend the period of time during which the water temperature exceeds numeric temperature criteria.

This last point isn't discussed in any detail. (add example of change in length of time)

5.0 DERIVATION OF TMDL ELEMENTS

5.1 General

The target temperatures for this TMDL are the mean site potential temperatures plus the incremental increases allowed by the WQS (see Section 2). These allowable increases vary with jurisdiction, location in the river and the site potential temperature. Where jurisdictions overlap, the allowable incremental increases in this TMDL are based on the more stringent WQS. Table 2-3 lists the allowable increases over the site potential by river reach after accounting for differences between jurisdictions.

The water quality standards divide the Columbia and Snake rivers into different reaches, each with different target temperatures to meet as shown in Table 2-3. The target temperatures result from adding the allowable increases to the site potential temperature. However, whenever the allowable increase in a river reach would result in exceedance of the water quality standards downstream of that reach, the target temperature has to be adjusted down so that it does not result in exceedance of down stream water quality standards. This actually is the case all along the rivers. RBM10 simulations indicate that the reaches cannot be allocated the full incremental increase allowed by their segment-specific standards, because these increases would cause exceedances of downstream standards. The Oregon water quality standards for the lowest reach on the river, along the Oregon/Washington border (see Table 2-3), limit the allowable increase in temperature in the rest of the Columbia and Snake Rivers. The allowable temperature increases of the upstream reaches shown in Table 2-3 must all be adjusted down in order the meet the water quality standards of that down stream reach. In other words the ~~heat load~~ increase allowed in all the upstream reaches is determined constrained by the water quality standards of the lowest river reach.

Confusing? We didn't do it this way (adjust then). We simply allocated smallest to biggest until capacity at 42 reached

5.2 Target Sites

The TMDL must allocate heat ~~load~~ to 933 river miles to achieve the WQS at the furthest downstream reach of the river. The extent of this pollution problem and the attempt to address it at the basin scale necessitates the selection of a number of points-of-compliance or "target sites" that span the 933 miles. Target sites are locations in the river where the site potential temperatures are calculated and where impacts from allocations to up-gradient sources are evaluated.

In selecting target site locations, one option would be to use the downstream boundary of each segment as defined in the WQS. However, the reaches identified in Table 2-3 are quite large and vary considerably in terms of the heat sources they contain. The reaches defined in the WQS vary from containing no dams to containing 5 dams. They also vary in terms of the number of point sources they contain: ranging from no point sources to 65 point sources.

Another option, and the one selected for development of this TMDL, is to establish target sites at each dam location. As discussed in Section 4.2, the fifteen dams on the rivers have the greatest effect on temperature. The dam locations have also been the primary long-term monitoring locations in the basin. Therefore, each dam defines a reach for the TMDL with the dam located at the downstream end of the reach. Downstream of Bonneville Dam, five additional target sites are established on the basis of the distribution of point sources. River mile 112 is in the vicinity of the Portland Airport and at the downstream extremity of salmon spawning. River mile 95 is downstream of Portland and Vancouver. River mile 63 is downstream of Longview and six large dischargers. River mile 42 is downstream of all the large dischargers and was chosen as a target site because the cumulative impacts of all the point sources is greatest at that point. River mile 4 was chosen as the last target site because further downstream the river is more like an estuary than a river. In the Snake River, one additional target site was created at river mile 138, just downstream of Lewiston, ID. The target site or monitoring point for each reach is at the downstream end. For the dam reaches, the monitoring point is in the fore bay of the dam. Table 5-1 lists the target sites for each reach of the TMDL.

depth?
~~vertical~~ profiles?

bring discussion
of various
compliance
points
to here

Table 5-1: TMDL Target Sites

TMDL Reach	Target Site	River Mile
Columbia River		
Canadian Border to Grand Coulee Dam	Grand Coulee Dam	Columbia - 596.6
Grand Coulee Dam to Chief Joseph Dam	Chief Joseph Dam	Columbia - 545.1
Chief Joseph Dam to Wells Dam	Wells Dam	Columbia - 515.8
Wells Dam To Rocky Reach Dam	Rocky Reach Dam	Columbia - 473.7
Rocky Reach Dam to Rock Island Dam	Rock Island Dam	Columbia - 453.4
Rock Island Dam to Wanapum Dam	Wanapum Dam	Columbia - 415.4
Wanapum Dam to Priest Rapids Dam	Priest Rapids Dam	Columbia - 397.1
Priest Rapids Dam to McNary Dam	McNary Dam	Columbia - 292.0
McNary Dam to John Day Dam	John Day Dam	Columbia - 215.6
John Day Dam to The Dalles Dam	The Dalles Dam	Columbia - 191.5
The Dalles Dam to Bonneville Dam	Bonneville Dam	Columbia - 146.1
Bonneville Dam to River Mile 112	River Mile 112	Columbia - 112
River Mile 112 to River Mile 95	River Mile 95	Columbia - 95
River Mile 95 to River Mile 63	River Mile 63	Columbia - 63
River Mile 63 to River Mile 42	River Mile 42	Columbia - 42
River Mile 42 to River Mile 4	River Mile 4	Columbia - 4
Snake River		
Salmon River to RM 138	River Mile 138	Snake - 138
River Mile 138 to Lower Granite Dam	Lower Granite Dam	Snake - 107.5
Lower Granite Dam to Little Goose Dam	Little Goose Dam	Snake - 70.3
Little Goose Dam to Lower Monumental Dam	Lower Monumental Dam	Snake - 41.6
Lower Monumental Dam to Ice Harbor Dam	Ice Harbor Dam	Snake - 9.7

Critical Reach and Target Site

As noted above, upstream target temperatures have been adjusted to ensure that downstream criteria could be attained. As such, the critical reach was found to be the lowest most reach of the Columbia River, as assessed at Mile 4. ~~This is the only target site for which the TMDL target temperatures did not have to be adjusted downward from the water quality criteria.~~ In all the other reaches, the target temperatures have been established at levels slightly less than water quality criteria in order that criteria may be achieved at River Mile 4. Thus, the critical why is "critical reach"? (basis)

reach for this TMDL is the reach between Columbia River miles 42 and 4 and the critical target site is at river mile 4 on the Columbia River.

5.3 Seasonal Variation

Figure 5-1 is intended to illustrate the seasonal variation in the water quality standards, in water temperature, and in the effect that human activity has on water temperature at the critical target site. The figure shows the water quality criteria and the temperature regimes of the site potential and existing rivers at Columbia River Mile 42. The green lines depict the water quality criteria: 20 °C from June 1 through September 30 (day 152 through day 273) and 12.8 °C from October 1 through May 31 (day 274 through day 151). If the site potential temperatures exceed 20 °C from June 1 through September 30 and/or 12.8 °C from October 1 through May 31, then human activity can increase temperature over the site potential by only 0.14 °C. Any time that the site potential temperature is less than the applicable criterion (either 20 °C or 12.8 °C) then human activity can increase temperature over the site potential by 1.1 °C or up to the criterion which ever is less. See Section 2 and Table 2-3 for a description of the applicable water quality standards.

The blue and red curves on the graph represent site potential temperature and existing temperature respectively. There are four important observations from Figure 5-1:

1. water temperature does vary seasonally as would be expected;
2. both the site potential and the existing temperatures exceed the 20 °C criterion in the summer and the 12.8°C criterion in the fall.
3. The existing temperatures exceed the site potential temperatures in the summer, fall and early winter; and
4. The existing temperatures do not exceed site potential temperatures in the late winter, spring and early summer.

31st?

These observations on the seasonal variation of temperature in the river and the effects of human activity on temperature govern the development of the TMDL. Since existing temperatures do not exceed site potential temperatures from Feb 6 through July, water temperature does not exceed water quality standards during that period. Therefore water quality is not impaired during that period and no load allocations are required.

Beginning on August 1 or shortly after, existing temperature exceeds the 20 °C criterion and site potential temperature. Therefore water quality standards are exceeded and the TMDL must include allocations to ensure that temperature does not exceed site potential temperature by more than 0.14 °C.

Beginning on October 1 until almost October 31, existing temperatures exceed site potential temperature and the 12.8 °C criterion. Therefore water quality standards are exceeded and the TMDL must include allocations to ensure that temperature does not exceed site potential temperature by more than 0.14 °C.

Beginning about November 1 until February 5, existing temperatures exceed site potential temperatures but not the criteria. Water quality standards are exceeded but in this case the TMDL must include allocations to ensure that temperature does not exceed site potential temperature by more than 1.1 °C.

actual river

In summary, the water quality standards for temperature, temperature itself and the effects of human activities on temperature all vary seasonally during the year. In the winter and spring, water quality standards are not exceeded, and therefore the waters of the Columbia and Snake rivers are not impaired for temperature from human activities within the main stems. In the late summer and fall, water quality standards are exceeded and the site potential temperatures exceed the water quality criteria, requiring TMDL allocations for temperature that ensure temperature doesn't exceed site potential temperature + 0.14 °C. In the late fall and early winter water quality standards are exceeded but the site potential is less than water quality criteria requiring TMDL allocations that ensure temperatures don't exceed site potential + 1.1 °C. The seasonality of the TMDL is summarized as follows:

February 6 through July 31 - no allocations required;
August 1 through October 31 - allocations to achieve site potential Temperature + 0.14 °C;
November 1 through February 5 - allocations to achieve site potential Temperature + 1.1 °C.

See notes in exec summary (additions)

5.4 Critical Conditions

TMDLs must take into account critical conditions for stream flow, loading and water quality parameters (40 CFR § 130.7(c)(1)). In a TMDL, critical conditions are the conditions under which the pollutant sources can cause the water quality standards to be exceeded. Thus if WQS are met at the critical conditions they should also be met at the less than critical conditions.

It is difficult to establish critical conditions of stream flow, loading and water quality parameters (temperature in this case) for this TMDL because of the manner in which dams effect temperature and the manner in which the target temperature varies throughout the year. Dams do not discharge a heated effluent to the river. They effect temperature by altering stream geometry and current velocity. Therefore, dams don't necessarily have the greatest effect on temperature at the lowest flows as they would if they discharged a heated effluent at constant discharge rate to the river. Furthermore, since the target temperature varies throughout the year, the hottest time of the year is not necessarily the most likely time that water quality standards will be exceeded. To address these issues, critical conditions have been considered in this TMDL in two ways. First, the TMDL incorporates the natural variability in temperature by utilizing 30 years of hydrologic and climatic data and establishes target temperatures for each day of the year, thus accounting for temperature increases during all periods, not just the hot periods. Second, the TMDL is expressed in terms of temperature instead of load, more fully accounting for temperature increases under all possible flow (and therefore, load) conditions.

5.5 Loading Capacity

The loading capacity is the greatest amount of pollutant loading that a water can receive without violating water quality standards (40 CFR 130.2(f)). In this TMDL, the loading capacity is the daily target temperature at River Mile 4 of the Columbia River as depicted in Figure 5-2. The loading capacity is depicted in tabular form in Appendix B, Table 21. The loading capacity for any day may be translated into a daily load through application of equation 5-1. This load represents the total heat load allowable to the system without violating water quality standards. However, since it was determined that temperature was a more appropriate measure than daily loading for this TMDL, daily loads have not been explicitly calculated.

As discussed above, the critical target site for this TMDL is the lowest target site in the system, River Mile 4. The loading capacity that governs the allocations is computed at this site. It is the daily 30-year mean temperature at that site, calculated as the mean site potential temperature plus the incremental increase allowed by the water quality standard as discussed in Section 5.1. ~~Since there are no downstream target sites, no adjustment was needed to account for downstream heating.~~ Recall from the discussion in Section 3.2 that the site potential temperature varies from year to year based on climatic and hydrologic conditions. The loading capacity varies with the site potential temperature. To capture that variability, the loading capacity for the TMDL is the 30 year mean loading capacity for each day of the year.

The loading capacity for this TMDL has been expressed as temperature rather than as a thermal load. The regulations governing TMDL development provide for the expression of TMDLs as "either mass per time, toxicity, or other appropriate measure" (40CFR130.2(h)). Temperature is an appropriate measure in this TMDL due to the large variation in daily flows experienced in the river. Since river flow is regularly adjusted based on electricity, irrigation and fisheries requirements a wide range of flows may be experienced on any single day. Thus, by modifying flow at any dam the river could experience a fluctuation in thermal load without realizing any change in temperature. Since it is ultimately the river temperature which is important to protecting the fisheries (the most sensitive beneficial use) and temperature is the unit in which the criteria are expressed, it is more appropriate to express this TMDL in terms of temperature. In addition, temperature is an expression which is meaningful and can be more readily understood by the public, dam operators, and other stakeholders. As noted above, temperature can be easily converted to daily load at any given flow. However, little to no value would be added by this exercise.

5.6 Allocations

This TMDL accounts for the contributing heat sources to the main stems: For the purpose of this TMDL, natural background conditions, tributaries (non-point sources), dams and point sources. Natural background temperature is the site potential temperature. Tributaries are allocated their existing loads. Dams and point sources are allocated temperature increases over the site potential temperature at each target site. The RBM 10 model was used to determine the temperature increases that human activity in each river reach of the main stems could cause and still achieve ??

This is bouncing around...

the target temperature or loading capacity at Columbia River Mile 4. This TMDL allocates that increase over site potential at each target site among the dams and point sources. It makes specific allocations of temperature increase to dams and point sources. The specific point source wasteload allocations are expressed as megawatts. The megawatts discharged by the point sources result in the temperature increase allocated to point sources. The allocations to dams and point sources sum to the target temperature at each site. In this section the terms "gross load allocation" and "gross wasteload allocation" refer to the temperature increase allowed in a river reach from dams and point sources respectively.

This Section first describes how the gross wasteload allocations and load allocations were determined in sub-section 5.6.1. Sub-section 5.6.2 then provides details on determination of the specific wasteload allocations. Subsection 5.6.3 goes into detail on the load allocations.

5.6.1 Gross Allocations to Human Sources

The underlying philosophy used to establish this TMDL was to allocate available heat capacity to the smallest sources first and work up the list until the available capacity is fully allocated. That is, allocate existing heat load to as many sources as possible. This philosophy arises from the fact that there is insufficient capacity to provide the larger sources any meaningful relief since the total capacity to be allocated is only 0.14 °C most of the year. Therefore, the TMDL first allocates sufficient loads to account for existing discharges from individual NPDES permittees and 20 MW at each target site to account for general NPDES permittees. Any future growth will have to be part of the 20 MW allocated to general permits. The TMDL then allocates remaining capacity to account for as many of the dams as possible beginning with the dams with the smallest effect on temperature.

The analysis of NPDES point sources in the watershed indicates that the cumulative loading of temperature to be deminimus in comparison to the effects of the dams and never in and of itself results in exceedance of water quality standards. Figure 5-3 illustrates this point. The red curve in the figure represents the existing temperature regime at river mile 42, the point in the river where point sources have the greatest cumulative impact. The black curve represents what the temperature would be if the point sources did not discharge heat. Even if this TMDL were to allocate the site potential temperature to each point source (ie., a wasteload equal to meeting water quality standards at the end of the discharge pipe), the applicable water quality standards would not be attained in the waterbody because of the temperature increases caused by the dams. In fact, very little benefit would be realized in terms of temperature reductions needed by the dams to achieve water quality standards. At the same time however, EPA recognizes that discharged heat may have local effects even at very small quantities, and as such, should be limited to the extent practicable. Taking these two considerations into account, this TMDL therefore provides a cumulative wasteload allocation applicable to all NPDES facilities in each reach that never exceeds 0.14 °C whenever site potential temperature is greater than the water quality criteria. That is, the cumulative effects of all the NPDES point sources is never measurable when the river exceeds water quality criteria. EPA believes that the wasteload allocations in this TMDL are reasonable in light of the following factors.

1. The NPDES point sources, in the aggregate, contribute less than 0.14 °C to the total temperature within each reach when temperature exceeds water quality criteria;
2. Limiting the point source discharges to site potential temperatures will have no measurable effect on water quality and reducing them beyond the levels contemplated by the cumulative wasteload allocation is not necessary to achieve water quality standards;
3. ~~The majority of the temperature increases (as much as 6 °C) are cause by the larger dams: therefore, water quality standards cannot be achieved under Clean Water Act authorities, but rather need to be accomplished through federal, state, local and even, conceivably, international mechanisms.~~

sp. or impounded? in Table XX were determined as follows:

~~To determine what~~ the gross allocations to point sources ~~should be, the RBM 10 model was used to determine the increase in temperature that can be allowed at the target sites and still comply with the OR WQS in the lower reach along the Oregon/WA border.~~ Thirty years of water temperature were simulated at each Target Site by RBM 10. The 30 year mean temperature and flow from those simulations and the current thermal loads from existing dischargers were used to calculate the mean increase in temperature at each target site that results from the point source allocation every day of the year. Figures 4-1 and 4-2 show that the point sources cause the river ~~to approach~~ water quality standards only when site potential temperature exceeds the numeric water quality criteria. Table 5-2, Column 2 shows the highest temperature increases at each target site caused by point sources when site potential temperatures exceed numeric criteria. This condition was used as a baseline to quantify the additional increase in temperature (beyond the increase due to point sources) that could be allowed at each target site.

see equation 4.1

sp. or impounded? mean daily ~~[illegible]~~ effect [illegible]?

Using the 30-year record, RBM 10 was run iteratively, allocating sufficient temperature increase to the dams to account for their effect on temperature. We started with the dams with the smallest impacts (See Section 4.2 and Appendix F) and worked up the list until further allocations would result in exceedances in water quality standards. For the time period when site potential temperature tends to exceed the water quality criteria (August 1 through October 31), we could allocate sufficient temperature increases to Wells, Rocky Reach, Rock Island, Priest Rapids and The Dalles to account for their effects on temperature. Table 5-2, Column 3 shows max. temperature increases allowed at each target site as a result of dam operation at that site when the site potential temperature exceeds water quality criteria. The temperature increases in Table 5-2, Column 4 represent the total increase, based on the point sources and the dams, ~~that can be~~ that have been ~~caused by~~ allocated to human activity within each reach. These allocations ~~and still~~ meet the water quality standards at Columbia River Mile 4 when site potential temperature exceeds water quality criteria.

To determine the allowable increase in temperature due to dams during the time period when site potential temperature is less than water quality criteria (Nov 1 through February 5) RBM 10 was run iteratively to determine an increase that could be applied to all 15 dams. It turns out that all the dams can be allocated 0.12 °C increase during this time period.

Why not do this the same way as above - smallest to largest?

Table 5-3 summarizes the gross wasteload allocations and load allocations using the information in Table 5-2 for the period when site potential temperature exceeds criteria ~~and 0.12 °C increase during the period~~ and the period when site potential temperature is less than criteria.

Table 5-2: Increases in temperature at each target site when site potential temperature exceeds water quality criteria (August 1 - October 31)

(1) **Target Sites**	Maximum (2) **Increase Due to Point Source Allocations (°C)**	Maximum (3) **Increase Due to Dam ~~Operation~~ (°C)** Allocations	(4) **Total Increase Within Each Reach Due to All Allocations (°C)**
		Columbia River Sites	
Grand Coulee Dam	0.0009	0.0	0.0009
Chief Joseph Dam	0.0009	0.0	0.0009
Wells Dam	0.0005	0.22	0.2205
Rocky Reach Dam	0.0006	0.13	0.1306
Rock Island Dam	0.0009	0.07	0.0709
Wanapum Dam	0.0004	0.0	0.0004
Priest Rapids Dam	0.0004	0.28	0.2804
McNary Dam	0.019	0.0	0.019
John Day Dam	0.0008	0.0	0.0008
The Dalles Dam	0.0002	0.147	0.1472
Bonneville Dam	0.0015	0.0	0.0115
River Mile 112	0.008	0.0	0.008
River Mile 95	0.005	0.0	0.005
River Mile 72	0.027	0.0	0.027
River Mile 42	0.025	0.0	0.025
River Mile 4	0.0004	0.0	0.0004
		Snake River Sites	
Snake River Mile 138	0.04	0.0	0.04
Lower Granite Dam	0.001	0.0	0.001
Little Goose Dam	0.001	0.0	0.001
Lower Monumental Dam	0.001	0.0	0.001
Ice Harbor Dam	0.001	0.0	0.001

Do we need previous table?

Table 5-3: Gross wasteload allocations and load allocations at each target site

(1) Target Sites	(2) Gross WLA (°C)	(3) Gross LA (°C)		(4) Total Allocation (°C)	
Applicable Dates	**8/1 - 2/5**	**8/1 - 10/31**	**11/1 - 2/5**	**8/1 - 10/31**	**11/1 - 2/5**
Columbia River Sites					
Grand Coulee Dam	0.0009	0.0	0.12	0.0009	0.1209
Chief Joseph Dam	0.0009	0.0	0.12	0.0009	0.1209
Wells Dam	0.0005	0.22	0.12	0.2205	0.1205
Rocky Reach Dam	0.0006	0.13	0.12	0.1306	0.1206
Rock Island Dam	0.0009	0.07	0.12	0.0709	0.1209
Wanapum Dam	0.0004	0.0	0.12	0.0004	0.1204
Priest Rapids Dam	0.0004	0.28	0.12	0.2804	0.1204
McNary Dam	0.019	0.0	0.12	0.019	0.139
John Day Dam	0.0008	0.0	0.12	0.0008	0.1208
The Dalles Dam	0.0002	0.147	0.12	0.1472	0.1202
Bonneville Dam	0.0015	0.0	0.12	0.0015	0.1215
River Mile 112	0.008	0.0	0.0	0.008	0.008
River Mile 95	0.005	0.0	0.0	0.005	0.005
River Mile 72	0.027	0.0	0.0	0.027	0.027
River Mile 42	0.025	0.0	0.0	0.025	0.025
River Mile 4	0.0004	0.0	0.0	0.0004	0.0004
Snake River Sites					
Snake River Mile 138	0.04	0.0	0.0	0.04	0.04
Lower Granite Dam	0.001	0.0	0.12	0.001	0.121
Little Goose Dam	0.001	0.0	0.12	0.001	0.121
Lower Monumental Dam	0.001	0.0	0.12	0.001	0.121
Ice Harbor Dam	0.001	0.0	0.12	0.001	0.121

delete page ~~except nonpoint language~~

Effect of Gross Allocations on Dams

Redundant?

Under this allocation scheme, the temperature increases above site potential temperatures at each target site are effectively zero for 10 of the dams from August through October. This allocation of the entire allowable increase to the point sources and the smallest 5 dams is based on the philosophy to allocate heating capacity to as many sources as possible, the great disparity in the relative impact of dams and point sources on temperature and the minuscule benefit that the dams would receive from decreasing the thermal input of the point sources. Relative to the improvements required at the target sites, the benefits to the dams of reducing the thermal loads from point sources are very small. If the point sources are allowed no thermal load, the maximum improvement to water quality is less than 0.14 °C below Bonneville Dam when the site potential temperature is above the numeric criteria and 0.385 °C below Bonneville when site potential is below the numeric criteria. Much of the time there would not be a measurable improvement in water temperature by eliminating point source loads. Furthermore, the improvement in water quality still needed by the dams to achieve water quality standards would be affected very little by removing the point source loads. If the entire allowable increase in temperature were equally distributed among all the dams, each of them would be able to increase site potential temperature by 0.02 °C when the site potential is greater than the numeric criteria and 0.15 °C when the site potential is less than the numeric criteria.

move copy earlier in doc

Beating horse to death!

In a graphical representation of these allocation considerations, Figures 5-3 illustrates the extremely small difference made by the point sources. In the figure, the difference between the red curve, labeled "existing" and the blue curve, labeled "TMDL" represents the temperature improvement needed. The difference between the "Existing Curve" and the black curve labeled "No PT Sources" represents the temperature improvement realized by eliminating thermal load from the point sources. Eliminating the point source influence on temperature realizes a very small part of the temperature improvement needed and does not reduce the burden of the dams in improving temperature to a meaningful extent.

Effect of Gross Allocations on Nonpoint Sources

Background

Nonpoint sources enter the mainstems primarily through the tributaries and irrigation canals. Neither EPA nor the states possess information about specific nonpoint sources that may discharge directly to the mainstems. For this TMDL, the impacts from these sources would be expected to be minimal based on the analysis of point source and tributary impacts. In this TMDL, all tributaries are allocated their existing loads. It should be noted that this mainstem allocation does not preclude establishment of different load allocations for nonpoint sources in future TMDLs for those tributaries on the states' 303(d) lists. The basis for the tributary allocations is discussed in detail in Section 5.5.2.1.

Temperature Increases at Each Target Site

Table 5-3, Column 4 lists the temperature increases that can occur within each river reach and still achieve the water quality standards at Columbia River Mile 4. The daily target delete?

There is a (slight) difference between reach increase & target temp. estimation (should explain)

temperature at each target site is the temperature that results when human activity in each reach adds the temperature listed in Table 5-3. The site potential temperature varies quite a bit from year to year due to variability in weather and flow as well as, day-to-day with seasonal changes in weather and flow. Thus the daily target temperature which varies with the site potential varies from year to year. To capture that variability, the target temperature for the TMDL is the mean target temperature for each day of the year based on the 30-year record. The target temperatures for each target site are expressed graphically and in tabular form in Appendix B.

5.6.2 Individual Wasteload Allocations

The gross WLAs in Table 5-3 are the allowable temperature increases at each target site allocated to point sources. Section 4.2 discussed the effects of point sources on water temperature and Figures 4-1 and 4-2 illustrated the increase in temperature that results from point sources at River Mile 42 where the impact of the point sources is greatest. Section 5.6.1 explained how the temperature increases resulting from point sources were calculated and Table 5-2 listed the temperature increases resulting from point sources at each Target Site. Those temperature increases are the same ones identified in Table 5-3 where they are the Gross WLA at each Target Site. The individual WLAs discussed below are expressed as the heat load in megawatts that each point source can discharge. The combined point source ~~loads~~ (megawatts) within a target site reach result in the Gross WLA listed in Table 5-3.

~~daily max?~~ instantaneous maximum

~~monthly avg?~~

Because point sources are discharging a heat load into the river?

Group Allocations and Individual Allocations

Or is it for implementation in permits?

The existing point sources on the Columbia and Snake rivers range in size and effect on river temperature from very small domestic waste facilities with thermal loads as low as 0.01 MW (megawatts) to larger industrial facilities with loads as high as 540 MW. As was shown in Section 3, these facilities cumulatively do not increase water temperature by more than 0.14 °C, but some of the larger facilities do have substantial thermal loads.

To provide flexibility to the managers of these facilities and to the NPDES permitting authorities, small dischargers within each river reach are allocated a "group allocation". That is, one load is allocated collectively to all the dischargers in the group.

To determine which point sources should be included in the groups, we established a threshold temperature effect. In this TMDL, the maximum increase in temperature over site potential, when site potential exceeds the water quality criterion, is 0.14 °C. This value comes from the Oregon water quality standards which define a measurable temperature increase as 0.14 °C or greater. We set the temperature effect threshold for small dischargers at 10% of this measurable increase or 0.014 °C. For the purposes of this TMDL, point sources that increase the cross sectional average water temperature by 0.014 °C or less are grouped by reach and given group allocations. This determination was based on temperature and flow limits in the permit, or if there were no limits, worst case discharges. In addition, point sources authorized to discharge under general NPDES permits are included in the group allocations. There are a total of 11 point sources addressed through individual allocations, 95 individual permittees addressed through group allocations and 136 general NPDES permittees addressed through the group allocations.

Maximum Discharge Levels

The WLAs for this TMDL have been established using current information on the reasonable worst case temperature and effluent discharge from each facility. However, as the WLAs consider the discharges' affect on the cross-sectional average temperature at the target sites and not local impacts, they represent the maximum discharge levels that the point sources could receive when their NPDES permits are re-issued. The actual permit limits may be lower than the loads established here for at least two reasons: adherence to State/Tribal mixing zone requirements and application of State/Federal/Tribal technology requirements. When NPDES permits are renewed, the permitting authority will evaluate each facility's compliance with mixing zone requirements and technology requirements. The effluent limits in the permit may be lower than those established in this TMDL as a result of those analyses, ~~but they cannot be higher than the TMDL allocations.~~

Development of the Wasteload Allocations

There are 106 point sources with individual NPDES permits which have been considered in establishing this TMDL. Appendix C lists the point sources by river reach on the Columbia and Snake Rivers respectively. The appendix includes the existing thermal loads of each point source and the temperature and flow used to compute the load and indicates whether the facility will be part of a group allocation or receive an individual allocation.

The loads provided in Appendix C are computed in megawatts (equation 5-1). They are based on existing permit limits or reasonable worst case discharges from the facilities. That is, if the facility has permit limits for flow and temperature in its existing permit, they were used to calculate the load. If the facility does not have limits in its current permit, available monitoring data was evaluated to establish the highest load discharged by the facility under normal operating conditions. For some small dischargers for which there is no monitoring data conservative assumptions were used to establish the temperature used to compute load.

Equation 5-1: Point Source Heat Load in Megawatts

$$H = pC_pQ(\Delta T)(1000\frac{l}{M^3})\left(\frac{1W}{1\frac{J}{s}}\right)\left(\frac{1MW}{10^6 W}\right)$$

keep

H = heat load discharged in megawatts (MW)
p = density of water (1kg/l)
C_p = Specific heat of water (4182 j/kg-°C
Q = Flow rate (m^3/sec)
T = Temperature (°C)

Appendix C indicates that 11 of the facilities on the Columbia and Snake Rivers will be given individual wasteload allocations and 95 will be included in Group allocations. Ninety five of the 106 point sources caused an increase in cross sectional average temperature of 0.014 °C or less. The 11 point sources that have individual allocations cause more than 0.014 °C increase in the daily cross sectional average temperature, but the greatest of these in the Columbia River causes a 0.02 °C increase and in the Snake River a 0.06 °C increase.

Tables 5-4 and 5-5 summarize the point source loadings to the Columbia and Snake Rivers respectively. The tables provide the total allocation to the groups and the individual allocations and lists the facilities receiving individual allocations.

max daily

Table 5-4: Summary of Group and Individual Wasteload Allocations for the Columbia River

River Reach/Facility	Group Allocations	Individual Allocations
International Border to Grand Coulee	**21.37 MW**	**0.0 MW**
Grand Coulee to Chief Joseph	**24.53 MW**	**0.0 MW**
Chief Joseph to Wells	**23.78 MW**	**0.0 MW**
Wells to Rocky Reach	**28.01 MW**	**0.0 MW**
Rocky Reach to Rock Island	**90.80 MW**	**0.0 MW**
Rock Island to Wanapum	**20.46 MW**	**0.0 MW**
Wanapum to Priest Rapids	**20.0 MW**	**0.0 MW**
Priest Rapids to McNary	**244.13 MW**	**791.4**
Agrium Bowles Road		206.8 MW
Agrium Game Farm Road		384.5 MW
Boise Cascade Walulla		200.1 MW
McNary to John Day	**59.81 MW**	**0.0 MW**
John Day to The Dalles	**20.73 MW**	**0.0 MW**
The Dalles to Bonneville	**99.07 MW**	**0.0 MW**
Bonneville to River Mile 112	**163.27 MW**	**337.8 MW**
Fort James Camas		337.8 MW
River Mile 112 to River Mile 95	**926.3 MW**	**0.0 MW**
River Mile 95 to River Mile 72	**42.84 MW**	**1095.8 MW**
Boise/ St.Helens		219.56 MW
Coastal St. Helens		365.09 MW
PGE Trojan		511.15 MW
River Mile 72 to River Mile 42	**224.87 MW**	**1095.81MW**
Longview Fiber		455.4 MW
Weyerhouser Longview		338.7 MW
GP Wauna		301.71 MW
River Mile 42 to River Mile 4	**46.79 MW**	**0.0 MW**
River Mile 4 to River Mile 0	**26.28 MW**	**0.0 MW**

max daily

Table 5-5: Summary of Group and Individual Wasteload Allocations for the Snake River

River Reach/Facility	Group Allocations	Individual Allocations
Salmon River to River Mile 138	**30.28 MW**	**298.76**
Potlatch		298.76 MW
River Mile 138 to Lower Granite	**20.0 MW**	**0.0 MW**
Lower Granite to Little Goose	**20.02 MW**	**0.0 MW**
Little Goose to Lower Monumental	**21.39 MW**	**0.0 MW**
Lower Monumental to Ice Harbor	**20.004 MW**	**0.0 MW**
Ice Harbor to River Mile 0	**20.004**	**0.0 MW**

General Permits

The National Pollutant Discharge Elimination System authorizes the issuance of general permits to cover the discharge of categories of dischargers (40 CFR 122.28). The general permit may be written to regulate storm water point sources or categories of point sources other than storm water if the sources in the category all:

4. involve the same or substantially similar operations;
5. discharge the same types of wastes;
6. require the same effluent limitations or operating conditions;
7. require the same or similar monitoring; and
8. in the opinion of the State Director or EPA Regional Administrator, are more appropriately controlled under a general permit than under individual permits.

Table 5-6 lists the general permits that have been issued in Idaho, Oregon and Washington that could potentially result in discharges to the mainstem of the Columbia or Snake Rivers within this TMDL area. The permits listed as issued by EPA are general permits for facilities in Idaho as well as federal facilities and facilities on Indian lands in all three states.

The discharges allowed by the general permits listed in Table 5-6 are not expected to be a factor influencing temperature in the Columbia and Snake River mainstems. We believe that the contribution to temperature load from the sources covered by these general permits is minimal especially when compared to the temperature loads from the large individual permits and the impacts of the dams. Therefore, the wasteload allocations for the general permits are included in the group allocations. Under this TMDL, facilities can continue to be covered under the general permits and discharge as authorized by those permits. The nature of the facilities, the relative sizes of the discharges and the main stem, the seasonality of the discharges and the limitations and requirements in the permits all contribute to this finding. See Appendix D for more discussion of this finding. However, effluent monitoring for temperature should be included in all of the general permits so that the states can keep track of the loadings allowed to the river via the group allocations.

Management of the Group Allocations

The permitting authorities (EPA, ODEQ and Ecology) will have to develop a management plan to ensure that the groups don't become over allocated in the future. They will have to keep track of heat loads authorized through individual and general NPDES permits. If a group allocation is reached, the permitting authorities will have to restrict further heat loads or combine groups in such a manner that will ensure that the distribution of heat load is maintained such that water quality standards are met at Columbia River mile 4. This will have to be a coordinated effort among the three permitting authorities. This management plan should be developed as part of the TMDL Implementation plan.

Table 5-6: General NPDES Permits

Agency	Permit Name and Number	Number of Facilities
EPA	Concentrated Animal Feeding Operation IDG010000	0
EPA	Aquaculture and On-site Fish Processors IDG130000	0
EPA	Stormwater Permits for Industries and Municipalities	21
EPA	Stormwater Permits for Construction	20 total/3 current
ODEQ	Cooling Water/Heat Pumps 0100	1
ODEQ	Filter Backwash 0200	0
ODEQ	Fish Hatcheries 0300	5
ODEQ	Log Ponds 0400	0
ODEQ	Boiler Blowdown 0500	0
ODEQ	Suction Dredges 0700	0
ODEQ	Seafood Processing 0900	6
ODEQ	Stormwater Permit for Gravel Mining 1200A	1
ODEQ	Construction that Disturbs Five or More Acres 1200C	5
ODEQ	Construction that Disturbs Five or More Acres - Government Agencies 1200CA	0
ODEQ	Construction Activities, 1200-C Permit Administered by DEQ Agents 1200CM	0
ODEQ	Industrial Stormwater 1200Z	21
ODEQ	Oily Stormwater Runoff, Oil/Water Separators 1300	1
ODEQ	Tanks Cleanup and Treatment of Groundwater 1500A	2
ODEQ	Washwater 1700A	0
ODEQ	Non Contact Geothermal 1900	0
Ecology	Boatyard General Permit	2
Ecology	Dairy General Permit	0
Ecology	Sand and Gravel General Permit	3
Ecology	Stormwater General Permits	
Ecology	Upland Fin Fish Hatching and Rearing	8
Ecology	Water Treatment Plant	3
Ecology	Fruit Packers	14

5.6.3 Load Allocations

5.6.3.1 Nonpoint Sources

While tributaries convey both point and nonpoint pollution to the Columbia and Snake Rivers mainstems, they are treated as nonpoint sources of thermal energy in the context of this mainstem TMDL. There are 193 tributaries including seven significant irrigation return flows in the TMDL project area. Appendix E lists the 193 tributaries, their USGS Gauge Number, drainage area, average flow if available, whether or not they are on the 303(d) list for temperature, and whether or not they were part of the RBM 10 model. Note that thirty of the 193 tributaries are on the 303 (d) lists for temperature. There is no flow or temperature information available for many of the tributaries, and as already described in section 4, very few of the tributaries are large enough to effect water temperature in the mainstem. For these reasons, only the largest 25 tributaries are included as inputs in the RBM 10 model.
smaller

Generally, in TMDLs, the load allocation for tributaries is either the load needed to achieve WQS in the tributary or the load needed to achieve WQS in the main stem, whichever is more stringent. However, for this TMDL, the WQS for the mainstem and most of the tributaries are based on the site potential temperatures. Since, in most cases, the tributary loads that would occur if the tributaries were at site potential temperatures are not available, the site potential temperatures in the main stems have been estimated using existing tributary loads. The existing temperatures of the tributaries, particularly the 30 tributaries on the 303(d) lists, may be greater than their site potential temperatures, which would result in slightly higher heat loading than would be present under site potential conditions. But while the target temperatures of the mainstems may decrease a small amount due to future improvements in the tributaries, the temperature increase available for allocation to human activities in the mainstem will not change. Thus the tributary loads have been included as part of the background and are allocated their existing loads. Due to the lack of data on most of these tributaries and the fact that they have been incorporated into the background allocation, no numeric allocations have been explicitly developed for the tributaries. It is anticipated that future tributary TMDLs will establish a lower heat load for many of the tributaries. Where that occurs, those loads apply. To date, temperature TMDLs have been completed for three tributaries to the Columbia and Snake river main stems: the Umatilla River, the Hood River and the Wind River.

The gross WLA s and LAs given in Table 5-3 are for excess temperature added to the mainstems by point sources, nonpoint sources and dams. However, site potential temperature estimates for the main stems are based on existing tributary loads. So there is no excess temperature in the site potential estimates due to tributaries. Therefore, none of the load allocations in Table 5-3 apply to the tributaries or to non-point sources. When the tributaries are at site potential temperatures they do not cause any excess temperature in the mainstems. However, WQS for the tributaries allow small increases over site potential. When the TMDLs are completed for those tributaries, the target temperatures in the TMDLs may have to restrict those allowable increases to achieve the downstream standards in the mainstems just as upstream allowable increases are restricted in this TMDL.

huh?

huh?

Potential nonpoint source impacts directly to the main stems are insignificant or unquantifiable and thus not provided an allocation. Causes of nonpoint source impacts to water temperature are loss of shade, loss of temperature buffering from hyporheic and groundwater flows, and runoff from agriculture, forestry and development along the rivers ~~and creation~~ of impermeable ~~surfaces in the~~ watershed. Shade was not a major factor affecting temperature in the main stems because of the width of the rivers and their propensity to flood. Runoff directly to the main stems is minor during the warm part of the year when it would tend to affect water temperature, due to the precipitation patterns in the basin (see Appendix D). The loss of hyporheic and groundwater in-flows resulting from the construction of the dams and impermeable surfaces has likely reduced temperature buffering in the main stems and the number and extent of cold water refugia. Given the size of the main stems the affect of the loss of these inflows is likely to be local and not sufficient to alter the cross sectional average temperature of the rivers. These affects are not quantified in this TMDL and not provided an allocation.

redundant

5.6.3.2 Dams

Dam structures are not required to have NPDES permits. However, dams facilities can include point sources, such as domestic waste discharges and cooling water discharges. These discharges do receive NPDES permits and are included in the WLAs in this TMDL. But the dam itself does not receive an NPDES permit to pass water through its turbines and spillway structures. So we are including the temperature allocations for dams as LAs and reserving WLAs only for those point sources that require an NPDES permit.

target river

The LA for the dams proposed in this TMDL is an increase over site potential temperature. However, the temperature increase over site potential is a difficult statistic to monitor in the field or to develop temperature improvement measures around. To make the TMDL more useful in planning temperature improvement measures at the dams and monitoring, the LAs are also expressed in terms of ~~estimated water~~ temperature, temperature improvement needed at each dam, and temperature difference between respective target sites. These three analyses, taken together will allow for advanced planning to mitigate the temperature impacts of dams and for short and long term monitoring of the effectiveness of improvement measures in achieving the TMDL.

Why not say target temps are LAs and other stuff is simply additional info for implementation planning?

Water Temperature 8 organization!

Water temperature resulting from achievement of the TMDL WLA and LA is the target temperature as explained in Section 6.5.1. Target Temperature is expressed as the thirty year mean temperature. Appendix B illustrates the target temperature at each target site graphically and includes the daily targets in tabular form. The graphs in Appendix B include the target temperature and the existing temperatures, both as thirty year means. This illustrates the long term improvement in temperature that will be achieved by implementation of the TMDL and will be useful in monitoring the ultimate long term effectiveness of TMDL implementation. These target temperatures will not be useful in monitoring compliance during a specific year because they are means with considerable natural temperature variation around them. There will be warm

Note that target temp does include effects of pt. sources, therefore Δ between target and actual can be attributed to upstream dam impacts

Since this provides only lumped estimates, we have individual impact info.

years during which the site potential temperature will be considerably higher than depicted in the graphs in Appendix B. Ultimately, however, as the TMDL is implemented the long term mean temperatures in the river should equal the loading capacities or target temperatures depicted in Appendix 1.

Temperature Effect of ~~Improvements Needed~~ at Each Dam

RBM 10 was used to simulate impounded river conditions under the scenarios that each of the current 15 dams removed from the river. This illustrates the effect that each dam has on water temperature by itself. Appendix F displays the results graphically and in tabular form in terms of the 30 year mean difference between existing temperatures and temperatures with each dam removed. These values represent the estimated effect on temperature of each dam.

Why not put dams into site potential river?

Temperature Difference Between Successive Target Sites

RBM 10 was used to determine the difference in temperature in each segment between ~~all the successive~~ Adjacent dams when they are all achieving their TMDL LAs. Appendix G displays this information graphically and in tabular form as the 30 year means. There is considerable variation in the temperature difference between dams, even in the 30 year means. However, the temperature difference can be valuable in monitoring the effectiveness of implementation measures in the short term at specific dams. Scanning through Appendix G reveals that temperature differences between respective target sites is significantly altered by 5 of the dams: Grand Coulee, Lower Granite, Little Goose, Lower Monumental and Ice Harbor. With Grand Coulee Dam achieving its TMDL targets, the maximum temperature difference between the Canadian Border and the dam is about 1 °C and it occurs in the spring. Under current conditions, the maximum difference is over 6 °C and occurs in the fall. There is a similar relationship for the Snake River Dams. Under the TMDL, the maximum difference between ~~successive~~ adj target sites is generally less than 0.5 °C and occurs in the summer. Under current conditions, the maximum differences range from a 1 °C to 2 °C and occur in the fall. The short term effectiveness of implementation measures at these dams can be evaluated by comparing the temperature difference between successive target sites to the curves in Appendix G. While we would not expect exact matches because the curves in the appendix are for 30 year means, we would expect the data to emulate the patterns in the curves: that is, the relative magnitude of the differences and the timing of the curve. For example. If the maximum exceedances in the lower Snake River are in June and less than 0.5 °C, the implementation measures are probably effective. If the maximum exceedances are in October and over 1 °C, the measures are probably not effective.

Summary

Note challenge ~~[illegible]~~ measurement of error.

The LA for all the dams is 0.01 °C above site potential except for Priest Rapids where it is 0.09 °C above site potential. In order to facilitate advanced planning to mitigate the temperature impacts of dams and for short and long term monitoring of the effectiveness of improvement measures in achieving the TMDL three other measures of temperature have been included with the allowable increases in temperature at each dam:

9. ~~overall~~ water temperature at each dam that will result from the attainment of the TMDL allocations;
10. improvement needed at each dam to achieve the TMDL, and
11. temperature differences between respective TMDL Target Sites.

The overall 30 year mean water temperature that will result at each target site demonstrates the improvement in water temperature that can be achieved. It is the desired end point of long term temperature monitoring to evaluate implementation of the TMDL.

The improvement needed at each dam can serve to prioritize dams for implementation actions. It shows the magnitude of improvements needed and the time of year they are needed.

The temperature differences between respective TMDL Target Sites will allow short term, dam specific assessment of the efficacy of measures taken at each dam.

5.7 Margin of Safety

Margins of safety can be explicit or implicit. Explicit margins of safety include:

12. setting numeric targets at more conservative levels than analytical results indicate;
13. adding a safety factor to pollutant loading estimates;
14. allocating a portion of the loading capacity to the margin of safety.

Implicit margins of safety include:

15. Conservative assumptions in derivation of ~~temperature~~ water quality targets~~;~~ or source allocations.
16. Conservative assumptions when developing the numeric model applications.

These explicit forms of a margin of safety pose the problem of requiring water quality to surpass the site potential. Often in environmental analysis it is better to err on the conservative side because that offers greater protection in the face of analytical errors. In this case, however, that philosophy can result in desired improvements that are not possible to attain. Because of the importance of site potential temperatures in this TMDL it is important to err as little as possible on either side. That was a major reason for using a one-dimensional rather than a two- or three-dimensional temperature model. With the data available or likely to be available in the near future, the cross sectional average temperature is more accurately simulated than the instantaneous temperatures throughout the depth and width of the water column.

~~Never-the-less,~~ There has been implicit margin of safety built into the TMDL.

17. For point sources the wasteload allocation does not vary with flow. It achieves water quality standards at the 7Q10 low flow, thereby providing a margin of safety when flows are greater than the 7Q10.

18. As described earlier in Section 3.3, the use of daily average target temperatures is a conservative application of the WQS that addresses the effect of dams on diel temperature fluctuation.

5.8 Future Growth

Future growth has been allowed for in this TMDL through the allocation of 20 MW of heat energy at each of the 21 Target Sites. Though this is a small amount of energy it allows for considerable growth along the river. For comparison purposes, the City of Pasco sewage treatment plant is allocated 22.75 MW.

The 20MW is also for gp's and nonpoint, right? How do you administer it? (e.g., do you need to estimate gp & nps loads at some point?)

5.9 Monitoring Plan

Long term, system wide effectiveness of TMDL implementation activities can be assessed by monitoring mainstem river temperatures at the target sites. Over the long term, if implementation is adequate, the daily mean temperatures at the target site should equal the 30 year mean target temperatures at those sites. Individual years may exceed those temperatures because of natural variation.

Short term monitoring for compliance with WLAs will be accomplished through effluent monitoring by the point sources. For individual dams, one option for short term monitoring is to evaluate the temperature difference between successive dams. The TMDL includes curves showing the temperature differences for existing conditions and for the conditions of the implemented TMDL. Effectiveness of TMDL implementation within individual impoundments can be determined by comparison of actual temperature differences between dams to the TMDL curves.

A temperature monitoring plan including clear, well defined objectives and a quality assurance/quality control component should be developed as part of the TMDL implementation plan. The objectives of the plan should include characterization of point source effluent temperature, and of daily average temperature at the target sites and in critical fish habitat and fish holding facilities in and around the dams.

In-river water temperature measurements should be collected in the fore bays of the dams but not right next to the dam structure. The monitoring site should be a sufficient distance from the structure to provide a representative estimate of daily average temperature of the forebay. Surface water temperature against the structure is likely to be influenced by the heated concrete of the dam and not representative of the temperature regime in the forebay. A minimum design at these sites would be a total of nine locations configured as three equally-spaced moorings across the width of the river, with three temperature probes per mooring at approximately equally-spaced intervals in the vertical. In addition, single, continuous temperature monitoring sites should be located in fish passage facilities, juvenile holding areas and other critical fish habitat near the dams.

Recent mon. indicates that one vertical string in forebay is adequate for Snake R. dams.

6.0 Summary of the TMDL, WLAs and LAs

Table 6.1 summarizes the TMDL, the WLAs and the LAs for each river reach. The load avaliable for allocation, as well as the gross WLA and the gross LA are prsented in bold for each river reach. The Group WLA, the individual WLAs and the individual LA follow the gross allocations for each reach. The Group and individual WLAs are given as megawatts. The LAs are given as the temperature increase in °C that the facility is allowed.

Table 6-1: Summary of the Columbia/Snake River TMDL, showing gross allocations for each river reach and individual wastload or load allocation for each facility in every reach.

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation**	**Load Allocation**	
	Aug 1 - Oct 31	**Nov 1 - Feb 5**	**Aug 1 - Feb 5**	**Aug 1 - Oct 31**	**Nov 1 - Feb 5**
	COLUMBIA RIVER FACILITIES				
International Border to Grand Coulee	**.0009 °C**	**0.1209 °C**	**0.0009 °C**	**0.0 °C**	**0.12 °C**
Group			21.37 MW		
Grand Coulee Dam				0.0 °C	0.12 °C
Grand Coulee to Chief Joseph	**.0009 °C**	**0.1209 °C**	**0.0009 °C**	**0.0 °C**	**0.12 °C**
Group			24.53 MW		
Chief Joseph Dam				0.0 °C	0.12 °C
Chief Joseph to Wells	**.2205 °C**	**0.1205 °C**	**0.0005 °C**	**0.22 °C**	**0.12 °C**
Group			23.78 MW		
Wells Dam				0.22 °C	0.12 °C
Wells to Rocky Reach	**.1306 °C**	**0.1206 °C**	**0.0006 °C**	**0.13 °C**	**0.12 °C**
Group			28.01 MW		
Rocky Reach Dam				0.13 °C	0.12 °C
Rocky Reach to Rock Island	**0.0709 °C**	**0.1209 °C**	**0.009 °C**	**0.07 °C**	**0.12 °C**
Group			90.80 MW		
Rock Island Dam				0.07 °C	0.12 °C

River Reach / Facility	Temperature Increase Allowed Within Each Reach		Wasteload Allocation	Load Allocation	
	Aug 1 - Oct 31	Nov 1 - Feb 5	Aug 1 - Feb 5	Aug 1 - Oct 31	Nov 1 - Feb 5
Rock Island to Wanapum	**.0004 °C**	**0.1204 °C**	**0.0004 °C**	**0.0 °C**	**0.12 °C**
Group			20.46 MW		
Wanapum Dam				0.0 °C	0.12 °C
Wanapum to Priest Rapids	**.2804 °C**	**0.1204 °C**	**0.0004 °C**	**0.28 °C**	**0.12 °C**
Group			20.0 MW		
Priest Rapids Dam				0.28 °C	0.12 °C
Priest Rapids to McNary	**.019 °C**	**0.139 °C**	**0.019 °C**	**0.0 °C**	**0.12 °C**
Group			244.13 MW		
Agrium Bowles Road			206.8 MW		
Agrium Game Farm Road			384.5 MW		
Boise Cascade Walulla			200.1 MW		
McNary Dam				0.0 °C	0.12 °C
McNary to John Day	**0.0008 °C**	**0.1208 °C**	**0.0008 °C**	**0.0 °C**	**0.12 °C**
Group			59.81 MW		
John Day Dam				0.0 °C	0.12 °C
John Day to The Dalles	**0.1472 °C**	**0.1202 °C**	**0.0002 °C**	**0.147 °C**	**0.12 °C**
Group			20.73 MW		
The Dalles Dam				0.147 °C	0.12 °C

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation**	**Load Allocation**	
	Aug 1 - Oct 31	**Nov 1 - Feb 5**	**Aug 1 - Feb 5**	**Aug 1 - Oct 31**	**Nov 1 - Feb 5**
The Dalles to Bonneville	**.0015 °C**	**0.1215 °C**	**0.0015 °C**	**0.0 °C**	**0.12 °C**
Group			99.07 MW		
Bonneville Dam				0.0 °C	0.12 °C
Bonneville to River Mile 112	**.008 °C**	**0.0 °C**	**.008°C**	**0.0 °C**	**0.0 °C**
Group			163.27 MW		
Fort James Camas			337.8 MW		
River Mile 112 to River Mile 95	**0.005 °C**	**0.0 °C**	**.005 °C**	**0.0 °C**	**0.0 °C**
Group			926.3 MW		
River Mile 95 to River Mile 72	**0.027 °C**	**0.0 °C**	**0.027 °C**	**0.0 °C**	**0.0 °C**
Group			42.84 MW		
Boise/ St.Helens			219.56 MW		
Coastal St. Helens			365.09 MW		
PGE Trojan			511.15 MW		

River Reach / Facility	Temperature Increase Allowed Within Each Reach		Wasteload Allocation	Load Allocation	
	Aug 1 - Oct 31	Nov 1 - Feb 5	Aug 1 - Feb 5	Aug 1 - Oct 31	Nov 1 - Feb 5
River Mile 72 to River Mile 42	**0.025 °C**	**0.0 °C**	**0.025 °C**	**0.0 °C**	**0.0 °C**
Group			224.87 MW		
Longview Fiber			455.4 MW		
Weyerhouser Longview			338.7 MW		
GP Wauna			301.71 MW		
River Mile 42 to River Mile 4	**0.0004 °C**	**0.0 °C**	**0.0004 °C**	**0.0 °C**	**0.0 °C**
Group			46.79		
River Mile 4 to River Mile 0	**0.00005 °C**	0.0 °C	**0.00005 °C**	**0.0 °C**	0.0 °C
Group			26.28		

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation**	**Load Allocation**	
	Aug 1 - Oct 31	**Nov 1 - Feb 5**	**Aug 1 - Feb 5**	**Aug 1 - Oct 31**	**Nov 1 - Feb 5**
	SNAKE RIVER FACILITIES				
Salmon River to River Mile 138	**0.04 °C**	**0.0 °C**	**0.04 °C**	**0.0 °C**	**0.0 °C**
Group			**30.28 MW**		
Potlatch			298.76 MW		
River Mile 138 to Lower Granite	**0.001 °C**	**0.121 °C**	**0.001 °C**	**0.0 °C**	**0.12 °C**
Group			20.0 MW		
Lower Granite Dam				0.0 °C	0.12 °C
Lower Granite to Little Goose	**0.001 °C**	**0.121 °C**	**0.001 °C**	**0.0 °C**	**0.12 °C**
Group			20.02 MW		
Little Goose Dam				0.0 °C	0.12 °C
Little Goose to Lower Monumental	**0.001 °C**	**0.121 °C**	**0.001 °C**	**0.0 °C**	**0.12 °C**
Group			21.39 MW		
Lower Monumental Dam				0.0 °C	0.12 °C
Lower Monumental to Ice Harbor	**0.001 °C**	**0.121 °C**	**0.001 °C**	**0.0 °C**	**0.12 °C**
Group			20.004 MW		
Ice Harbor Dam				0.0 °C	0.12 °C
Ice Harbor to River Mile 0	**0.001 °C**		**0.001 °C**	**0.0 °C**	**0.0 °C**
Group			20.004 MW		

7.0 References Cited

Bonneville Power Administration et al. 1994. *Columbia River system operation review.* Appendix M, Water quality. DOE/EIS-0170. Bonneville Power Administration, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation, Portland, Oregon.

Code of Federal Regulations. 40 CFR 131.35 *Colville Confederated Tribes Indian Reservation.*

Environmental Protection Agency. 2001. Letter of January 25, 2001, from Randall F. Smith, Director, Office of Water, EPA Region 10 to David Mabe, Administrator, State Water Quality Programs, Idaho Department of Environmental Quality.

Idaho Administrative Code. IDAPA 16.01.02, *Water Quality Standards and Wastewater Treatment Requirements.*

McKenzie, S.W., and A. Laenen. 1998. *Assembly and data-quality review of available continuous water temperatures for the main stems of the lower- and mid-Columbia and lower-Snake rivers and mouths of major contributing tributaries.* NPPC Contract C98-002. Northwest Power Planning Council, Portland, Oregon.

National Marine Fisheries Service (NMFS), 2000. *Endangered Species Act - Section 7 Consultation, Biological Opinion, Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin.* Http://www.nwr.noaa.gov/1hydrop/hydroweb/docs/Final/2000Biop.html

Normandeau Associates. 1999. *Lower Snake River temperature and biological productivity modeling.* R-16031.007. Preliminary review draft. Prepared for the Department of the Army, Corps of Engineers, Walla Walla, Washington.

Oregon Administrative Rules, OAR 340-041-0001 to OAR 340-041-000975. *State-Wide Water Quality Management Plan, Beneficial Uses, Policies, Standards and Treatment Criteria for Oregon.*

Oregon Department of Environmental Quality. 1998. Letter of June 22, 1998 from Michael T. Llewelyn, Administrator, Water Quality Division to Philip Millam, Director, Office of Water, EPA Region 10.

Oregon Department of Environmental Quality. 1998. *Water quality limited streams 303(d) list.* Oregon Department of Environmental Quality <http://waterquality.deq.state.or.us/wq/303dlist/303dpage.htm>.

Oregon Department of Environmental Quality. 2001. Letter of October 4, 2001 from Michael T. Llewelyn, Administrator, Water Quality Division to Randall F. Smith, Director, Office of Water, EPA Region 10.

U.S. Army Corps of Engineers, Walla Walla District. 2002. *Final Lower Snake River Juvenile*

Salmon Migration Feasibility Report/Environmental Impact Statement.

Washington Administrative Code Chapter 173-201A WAC, *Water Quality Standards for Surface Waters of the State of Washington.*

Washington Department of Ecology. 1998. Washington's final 1998 Section 303(d) list (impaired and threatened surface waters). <http://www.wa.gov/ecology/wq/303d/>.

Washington Department of Ecology. 2001. Letter of September 4, 2001, from Megan White, Water Quality Program Manager to Charles Findley, Acting Regional Administrator, EPA Region 10.

Yearsley, J.R. 1969. *A mathematical model for predicting temperatures in rivers and river-run reservoirs.* Working Paper No. 65, Federal Water Pollution Control Agency, Portland, Oregon.

Yearsley, J. R. 2001. Application of a 1-D Heat Budget Model to the Columbia River System. US Environmental Protection Agency, Seattle, WA.

I think this is "EPA, 2001" now.

~~Add Snake report?~~

Columbia/Snake Rivers Temperature TMDL
Preliminary Draft November 13, 2002
Figures

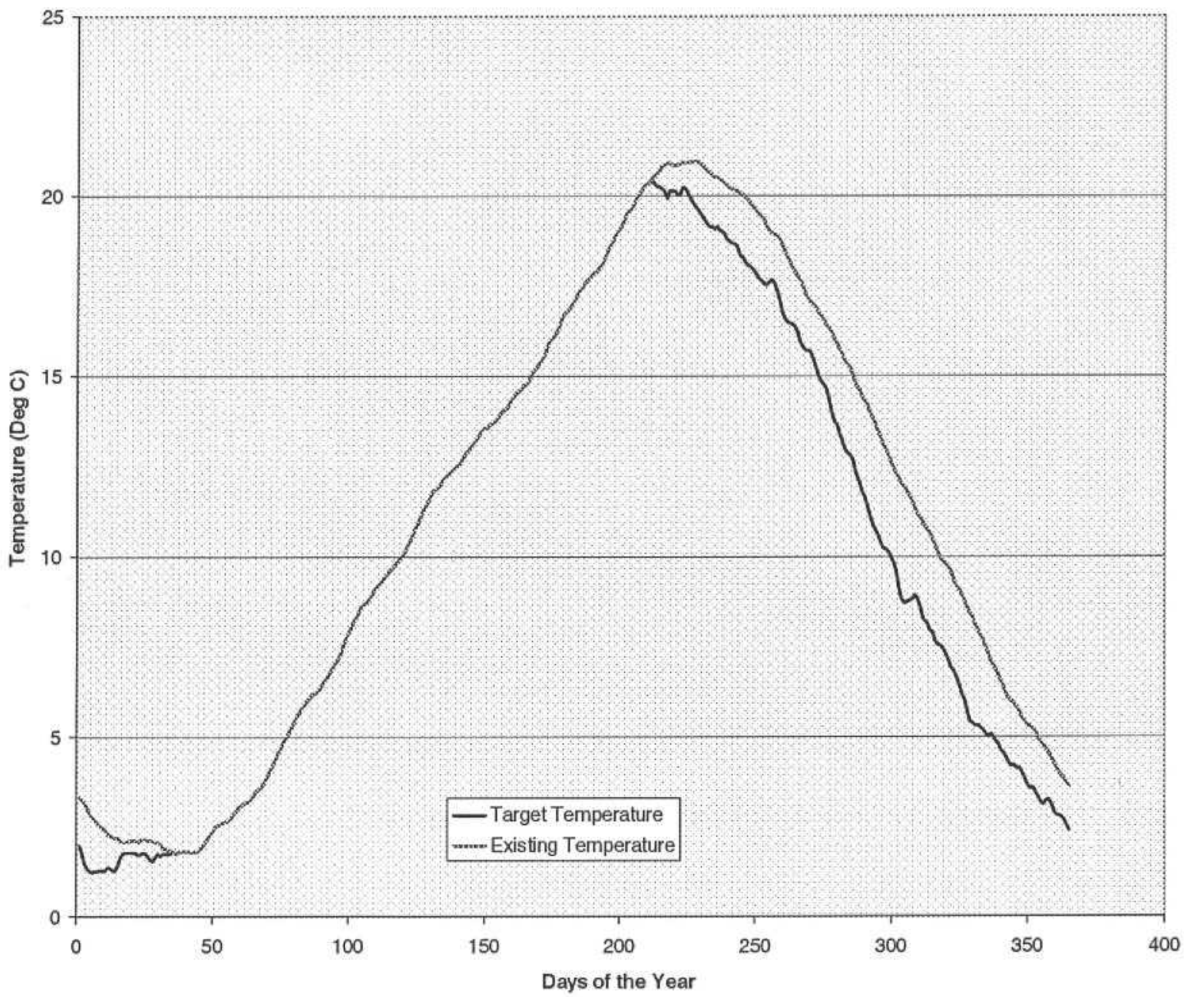

Figure S-1: Existing and TMDL target temperatures at John Day Dam

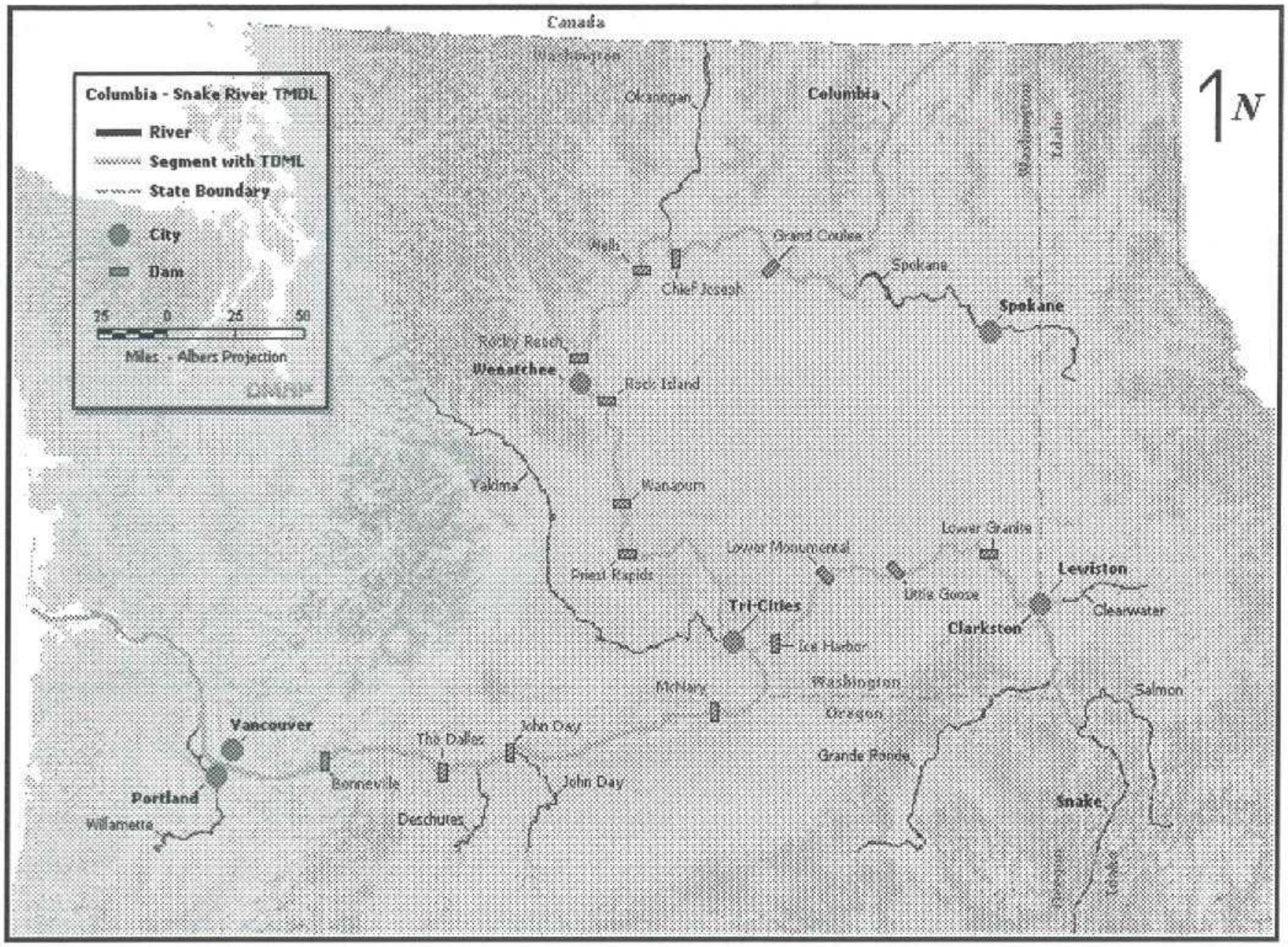

Figure1-1: The reaches of the Columbia and Snakes rivers covered by this TMDL

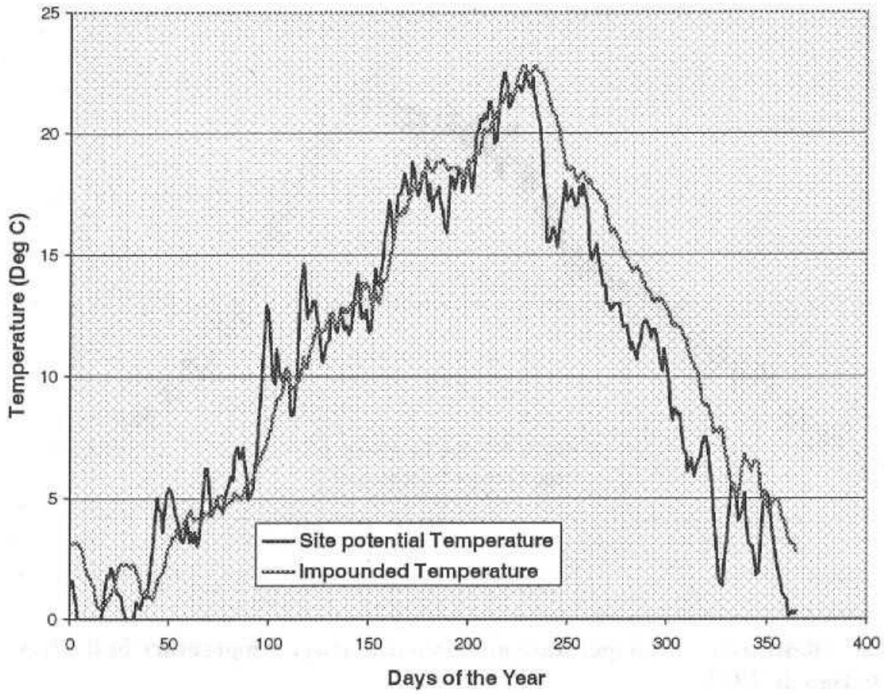

Figure 3-1: Simulated site potential and impounded temperatures at John Day Dam in 1977

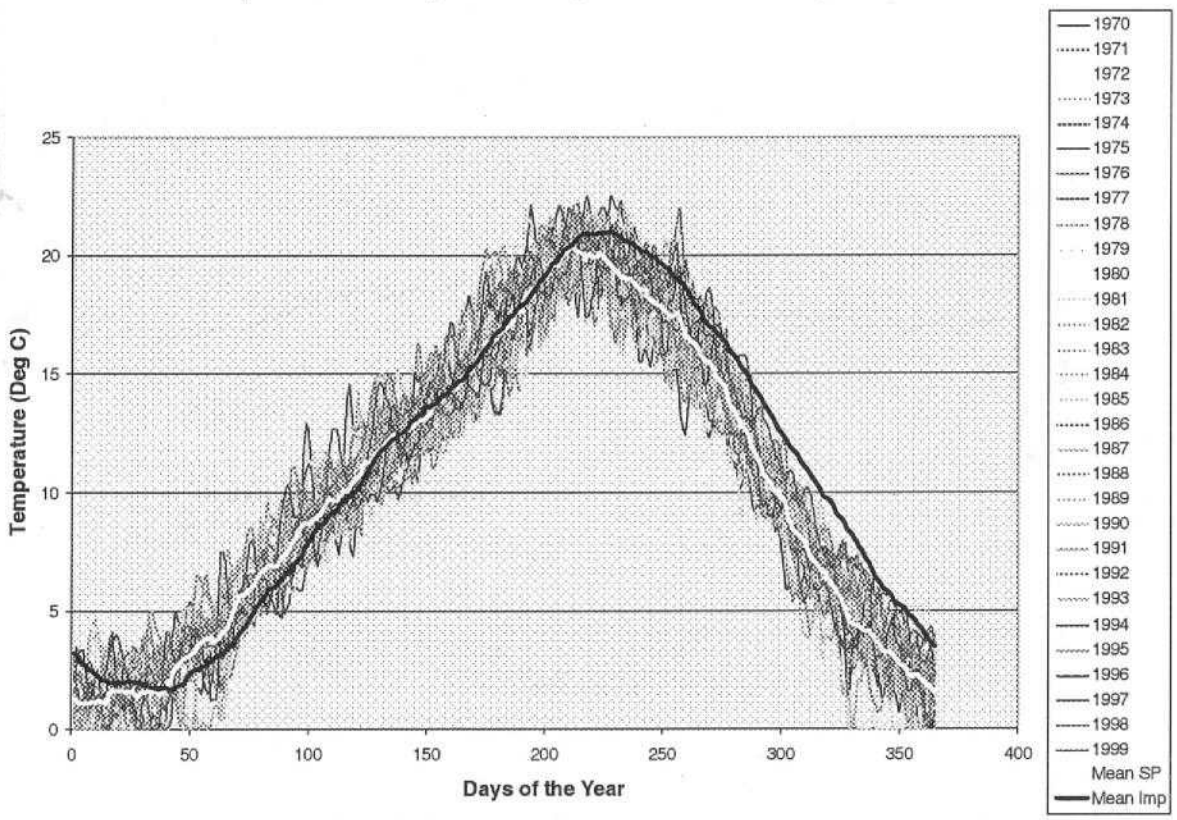

Figure 3-2: Simulated site potential temperatures at John Day Dam from 1970 through 1999.

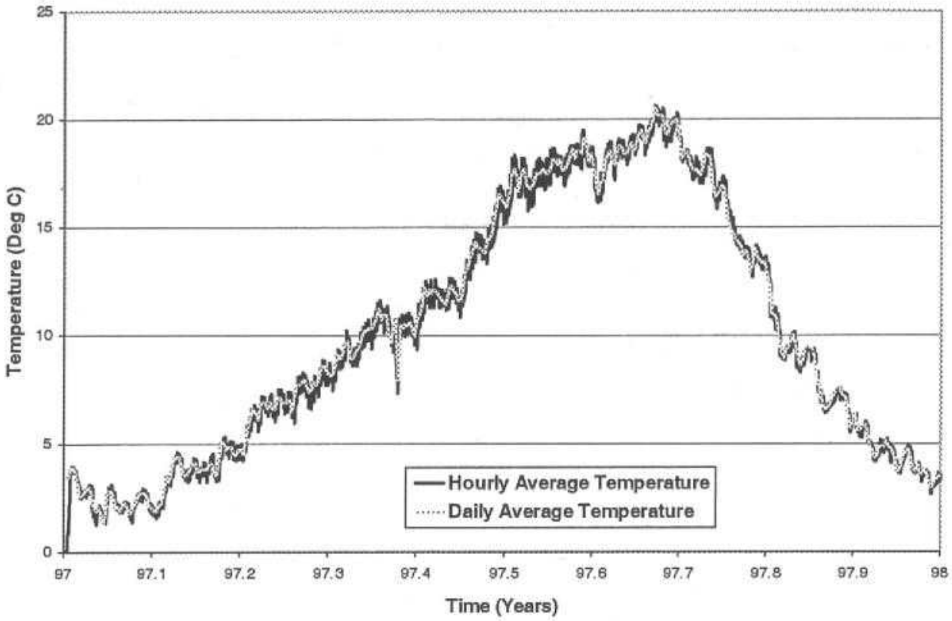

Figure 3-3: Simulations of daily average temperature and hourly average temperature in the free flowing river at Lower Granite Dam in 1997.

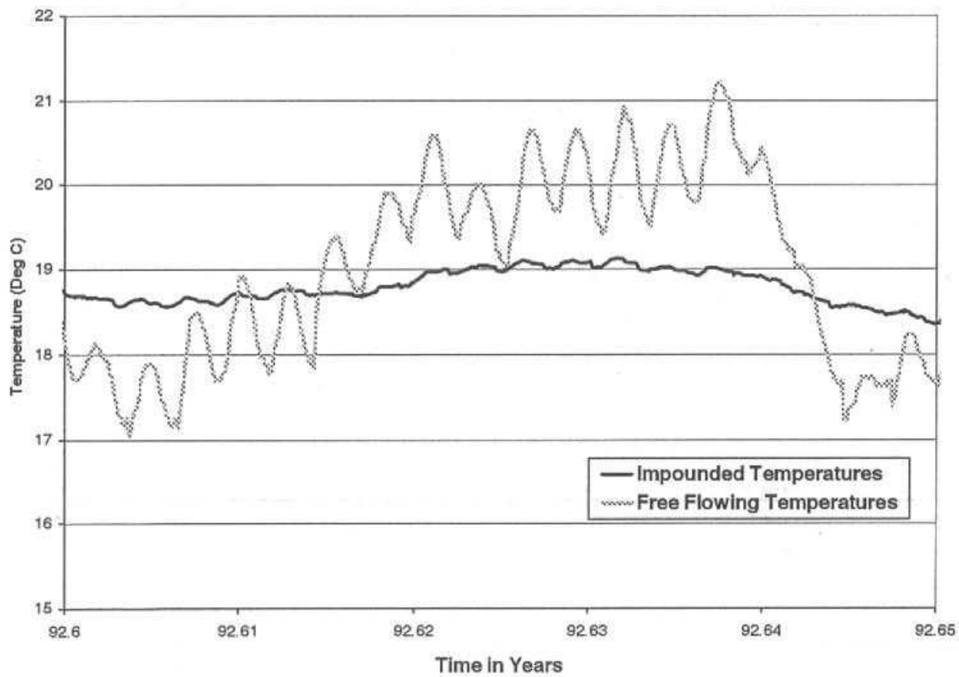

Figure 3-4: Simulated hourly average temperature in the impounded and free flowing rivers at Grand Coulee Dam from August 7, 1992 to August 25, 1992.

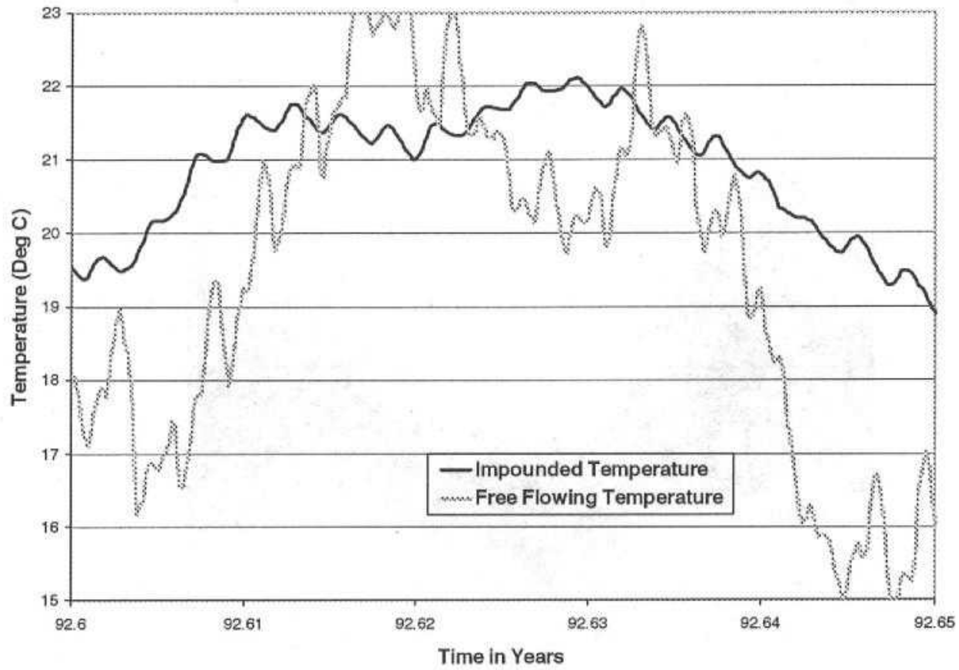

Figure 3-5: Simulated hourly average temperature in the impounded and free flowing rivers at Lower Granite Dam from August 7, 1992 to August 25, 1992.

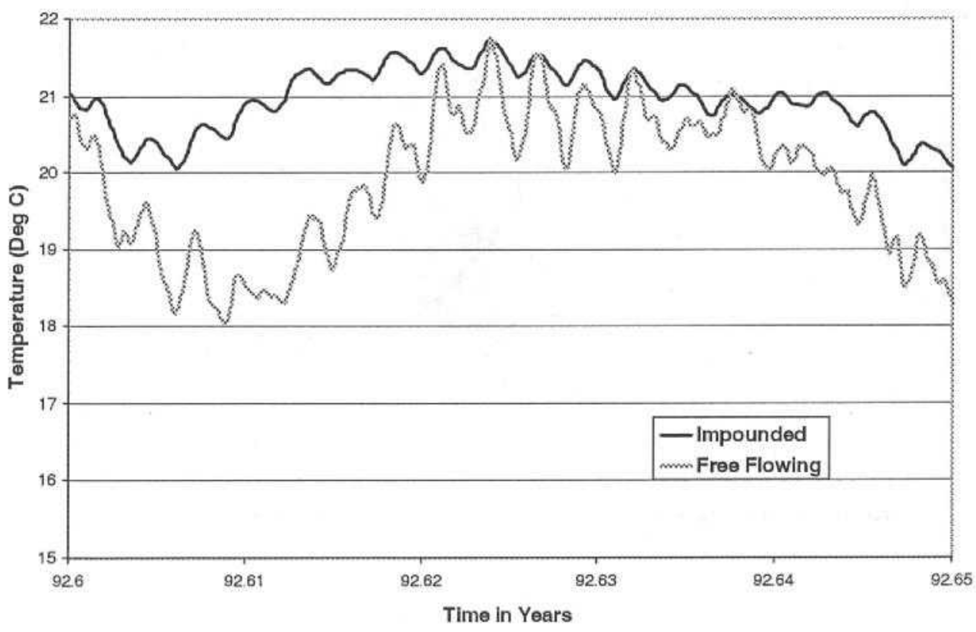

Figure 3-6: Simulated hourly average temperature in the impounded and free flowing rivers at Bonneville Dam from August 7, 1992 to August 25, 1992.

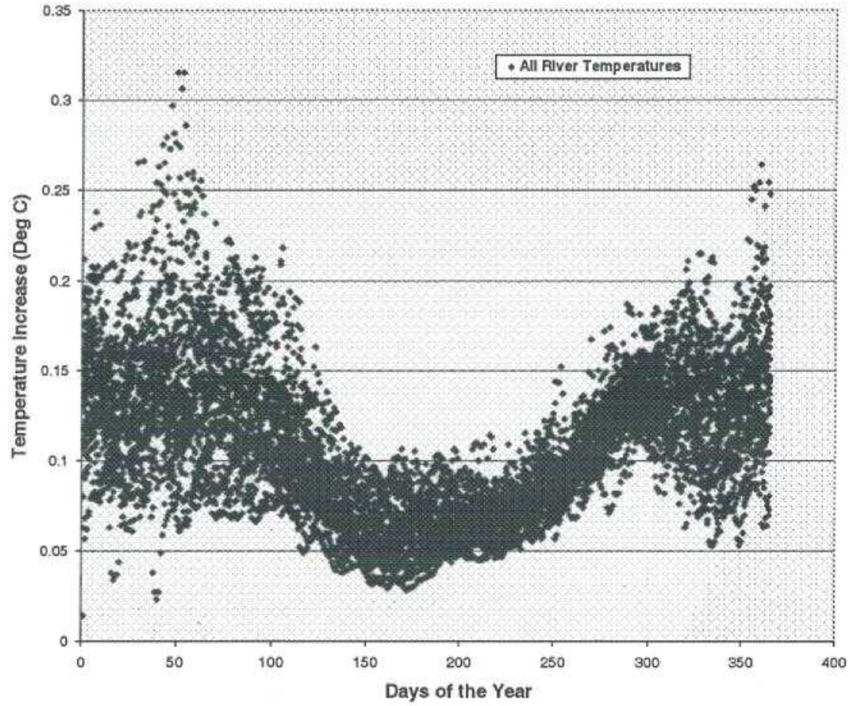

Figure 4-1: Simulated increases in temperature at river mile 42 in the Columbia River due to existing point sources plus 20 MW at each target site from 1970 through 1999.

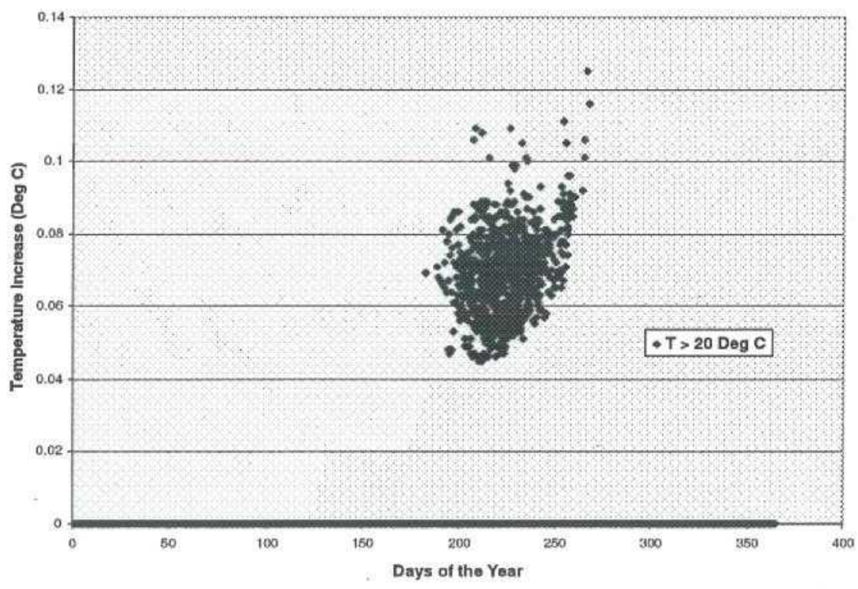

Figure 4-2: Simulated increases in temperature at river mile 42 in the Columbia River due to existing point sources plus 20 MW at each target site when site potential temperature exceeded 20 °C from 1970 through 1999.

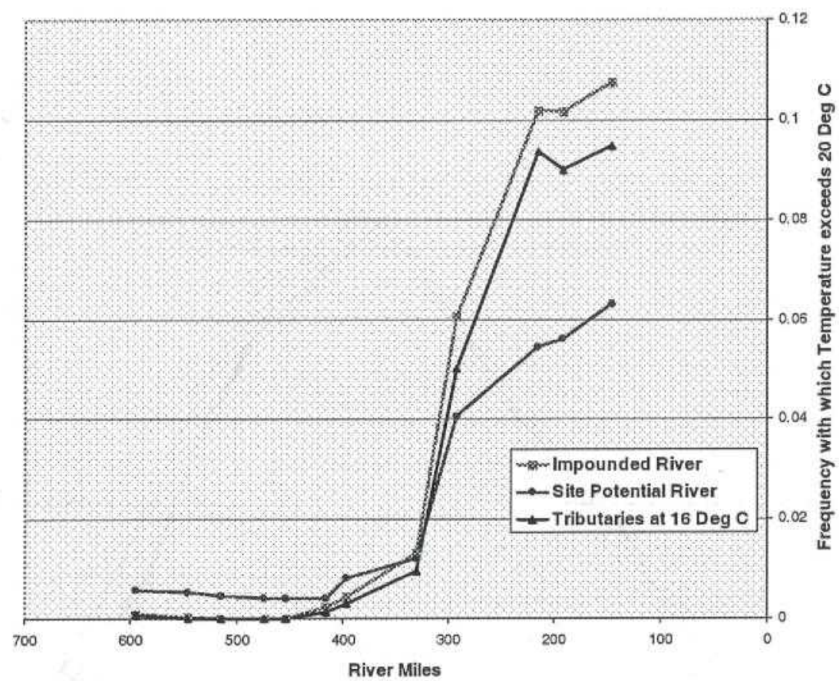

Figure 4-3: Frequency of predicted temperature excursions over 20 °C in the Columbia River for the existing impounded river, the site potential river and the impounded river with tributary temperatures constrained to 16 °C.

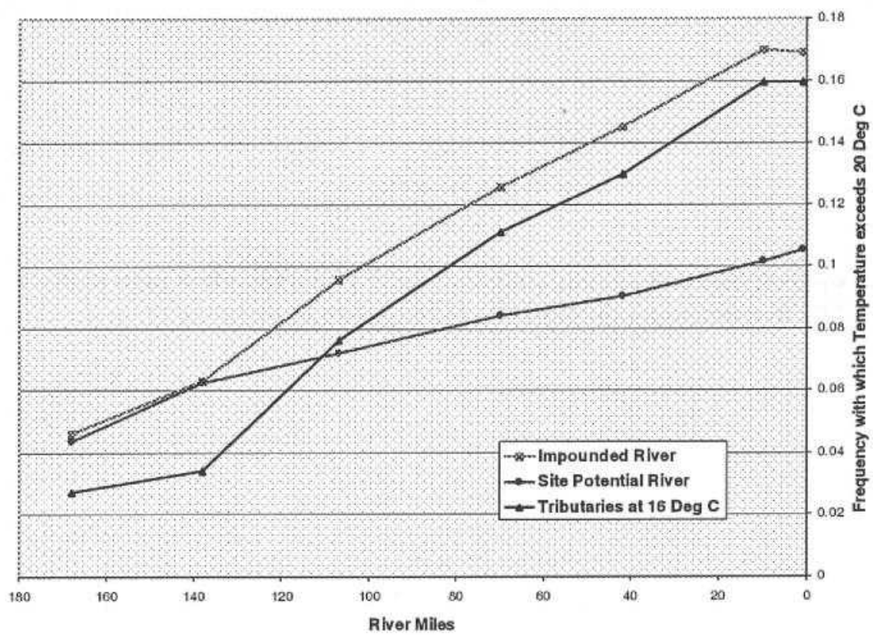

Figure 4-4: Frequency of predicted temperature excursions over 20 °C in the Snake River for the existing impounded river, the site potential river and the impounded river with tributary temperatures constrained to 16 °C.

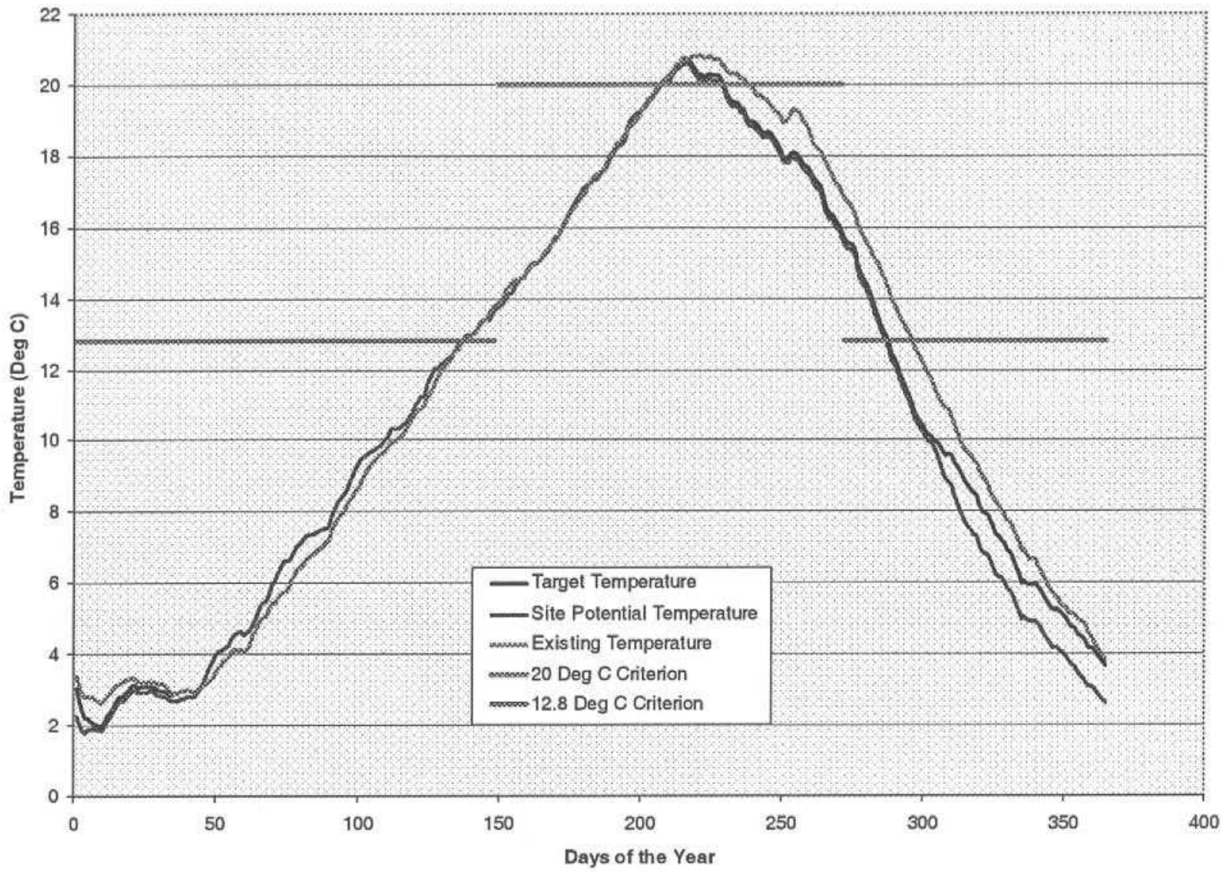

Figure 5-1: Target, site potential and existing temperatures at Columbia River mile 42 illustrating the seasonal variation. The seasonal water quality criteria are shown in green.

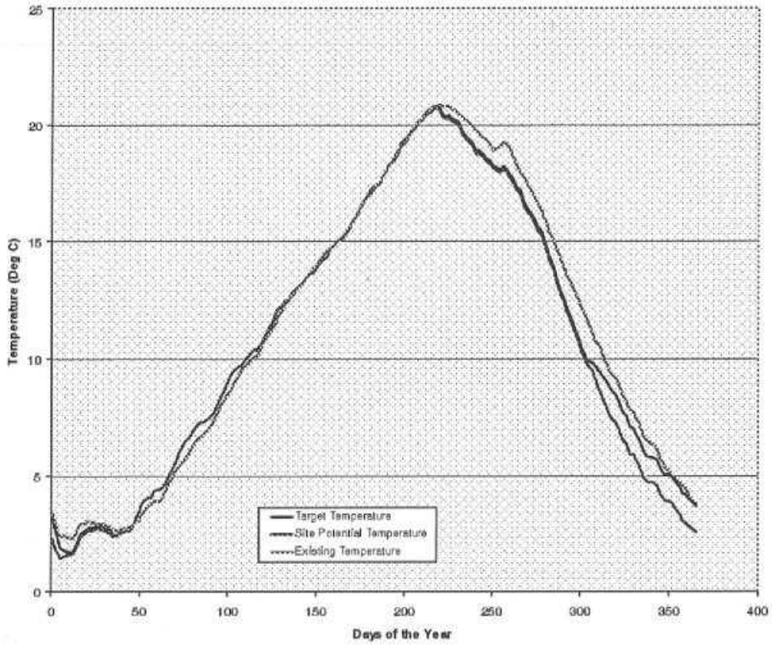

Figure 5-2: Water temperature at Columbia River mile 4 showing existing temperature, site potential temperature and the loading capacity temperature.

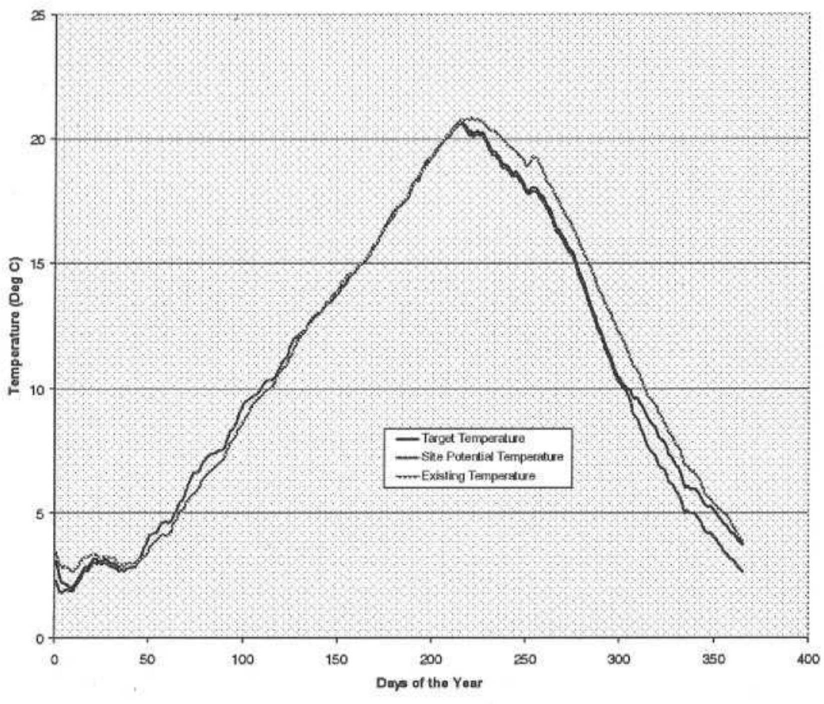

Figure 5-3: Water temperature at Columbia River mile 42 showing existing conditions, conditions with point source thermal loads removed and conditions under the proposed TMDL.

Appendix C: Point Sources Discharging to the Columbia and Snake Rivers

Note: The effluent flows, temperatures and resulting loads listed here are intended to represent reasonable worst case discharges from the facilities. Reasonable worst case consists of the highest flows and temperatures of the effluent under normal operating conditions. We have received information from the states that the effluent quality of 4 of the facilities listed below should be changed. The temperature for Boise Cascade Wallulla, Longview Fiber and Weyerhauser Longview should be changed from 33 °C to 38.8 °C. The flow and temperature for PGE Trojan should be changed from 3.6 m^3/sec and 33.9 °C to 0.001 m^3/sec and 22 °C. These changes were not made in this preliminary draft because the model runs have not yet been conducted utilizing these flows and temperatures. These changes will be incorporated into the draft unless further review dictates otherwise.

Table C-1: Sources by River Reach in the Columbia River

River Reach/Facility	Permit Number	River Mile	Flow (M^3/sec)	Temperature (°C)	Load (MW)	Form of Allocation
International Border - Grand Coulee						
Avista — Kettle Falls		702.4	0.01	32.2	1.37	Group
General Permits and Future Growth					20.0	Group
Grand Coulee - Chief Joseph						
Grand Coulee Dam	WA-002416-3	596.6	0.008	27.5	0.91	Group
Grand Coulee	WA 0044857B	596.6	0.03	20.0	2.52	Group
City of Coulee Dam	WA-002028-1	596	0.013	20.0	1.10	Group
General Permits and Future Growth					20.0	Group
Chief Joseph - Wells						
Chief Joseph Dam	WA-002242-0	545.1	0.00026	27.5	0.03	Group
Bridgeport STP	WA 002406 6	543.7	0.013	27.5	1.51	Group
Brewster	WA 0021008B	529.8	0.016	27.5	1.83	Group
Patteros STP	WA 0020555 9	524.1	0.004	27.5	0.41	Group
General Permits and Future Growth					20.0	Group
Wells - Rocky Reach						
Wells Dam	WA 005103 9	515.8	0.00004	20.0	0.0037	Group
Wells Hydro Project	WA 005104 7	515	0.0002	20.0	0.01	Group
Chelan STP	WA 002060 5	503.5	0.064	27.5	7.40	Group
Entiat STP	WA 005127 6	485	0.005	27.5	0.60	Group
General Permits and Future Growth					20.0	Group

River Reach/Facility	Permit Number	River Mile	Flow (M^3/sec)	Temperature (°C)	Load (MW)	Form of Allocation
Rocky Reach - Rock Island						
Rocky Reach Dam	WA 005079 2	474.9	0.00017	27.5	0.02	Group
Tree Top	WA 005152 7	470.8	0.004	22.0	0.33	Group
Naumes Processing	WA 005181-1	470.5	0.076	33.3	10.54	Group
Columbia Cold Storage	WA 002362 1	466.3	0.060	23.9	5.99	Group
E Wenatchee Sewer District STP	WA 00 2062-1	465.7	0.166	27.5	19.13	Group
KB Alloys	WA 0002976C	458.5	0.013	27.0	1.48	Group
Specialty Chemical	WA 0002861A	456.3	0.175	21.1	15.46	Group
Alcoa Wenatchee		455.2	0.197	21.6	17.85	Group
General Permits and Future Growth					20.0	Group
Rock Island - Wanapum						
Rock Island	WA 005078 4	453.4	0.0001	27.5	0.01	Group
Rock Island West Powerhouse	WA 005122 5	453.4	0.000087	27.5	0.01	Group
Vantage STP	WA 0050474B	420.6	0.0038	27.5	0.44	Group
General Permits and Future Growth					20.0	Group
Wanapum - Priest Rapids						
General Permits and Future Growth					20.0	Group
Priest Rapids - McNary						
Columbia Generating Sta	WA-002515-1	351.7	0.428	30.0	53.70	Group
Fluor Daniel Hanford, Inc	WA-0025917	347.0	0.24	27.9	27.90	Group
Richland STP	WA 002041 9	337.1	0.499	27.5	57.38	Group
Baker Produce	ST 9183	329.2	0.0003	27.5	0.04	Group
Twin City Foods	WA 0021768B	328.3	0.0003	28.3	0.04	Group
Kennewick	WA 004478 4	328.0	0.535	27.5	61.40	Group
Pasco	WA 0044962C	327.6	0.198	27.5	22.75	Group
Agrium Bowles Road plant	WA 000367 1	322.6	1.76	28.1	206.8	Individual
Agrium Game Farm Road plant	WA 000372 7	321.0	2.9	31.7	384.5	Individual
Sanvik Metals	WA 0003701B	32.0	0.011	20.0	0.92	Group
Boise Cascade Walulla		316.0	1.446	33.0	200.1	Individual
General Permits and Future Growth					20.0	Group

River Reach/Facility	Permit Number	River Mile	Flow (M^3/sec)	Temperature (°C)	Load (MW)	Form of Allocation
McNary to John Day						
Goldendale		216.7	0.365	26.1	39.81	Group
General Permits and Future Growth					20.0	Group
John Day - The Dalles						
Biggs OR		208.8	0.0023	23.9	0.24	Group
Wishram STP	WA 005129 2	200.8	0.004	27.5	0.49	Group
General Permits and Future Growth					20.0	Group
The Dalles - Bonneville						
Dalles/Oregon Cherry OR		189.5	0.0788	23.9	7.88	Group
Northwest Aluminum OR		188.9	0.063	33.3	8.79	Group
Cascade Fruit OR		188.3	0.0087	23.9	0.88	Group
Lyle	WA 005048 2	183.2	0.000087	27.5	0.01	Group
Mosier OR		174.6	0.0013	23.9	0.13	Group
SDS Lumber	WA 0051152B	170.2	0.46	28.3	54.7	Group
Bingen STP	WA 00 2237 3	170.2	0.035	27.5	4.03	Group
Hood River OR		168.4	0.0043	23.9	0.44	Group
Cascade Locks OR		151.0	0.0038	23.9	0.38	Group
Stevenson STP		150.0	0.02	22.2	1.83	Group
General Permits and Future Growth					20.0	Group
Bonneville - River Mile 112						
Tanner OR		144.2	0.011	24.0	1.11	Group
North Bonneville STP	WA0023388B	144.0	0.005	22.2	0.51	Group
Multnomah Falls OR		134.2	0.002	26.7	0.19	Group
BBA Nonwovens Washougal	WA0040177B	124.0	0.004	18.3	0.34	Group
Exterior Wood, Inc.		123.8	0.002	32.2	0.29	Group
Washougal STP	WA0037427B	123.5	0.98	22.2	9.11	Group
Camas STP	WA0020249A	121.2	0.267	22.2	24.81	Group
Fort James Camas		120.0	2.64	30.6	337.8	Individual
Toyo Tanso USA OR		118.1	0.002	23.4	0.20	Group
Gresham OR		117.4	1.1	23.0	106.71	Group
General Permits and Future Growth					20.0	Group

River Reach/Facility	Permit Number	River Mile	Flow (M^3/sec)	Temperature (°C)	Load (MW)	Form of Allocation
River Mile 112 - River Mile 95						
Marine Park Water Reclamation Facility	WA0024368C	109.5	0.7	22.0	64.43	Group
Vancouver Ice & Fuel Oil	WA0039918B	106.0	0.0001	20.0	0.01	Group
Graphic Packaging OR		105.6	0.279	27.0	31.50	Group
Northwest Packing Co.	WA0042064A	105.2	0.002	38.0	0.35	Group
Portland STP OR		105.0	5.547	22.5	521.94	Group
Great Western Malting	WA0000019B	105.0	0.434	20.0	36.28	Group
Vancouver Westside STP		105.0	2.013	21.7	183.02	Group
Support Terminal Services	WA0000418B	104.8	0.00006	27.5	0.01	Group
Clark County PUD Lower River Rd	WA0040932A	103.2	0.031	40.0	5.20	Group
Van Alco		103	0.218	27.7	25.32	Group
Salmon Creek STP		95.5	0.412	22.2	38.24	Group
General Permits and Future Growth					20.0	Group
River Mile 95 - River Mile 72						
Boise/St Helens OR		85.8	1.5	35.0	219.56	Individual
Columbia River Carbonates	WA0039721B	83.5	0.044	32.2	5.90	Group
Coastal St Helens OR		82.6	2.188	39.9	365.09	Individual
Clariant Corp	WA0000353B	76.0	0.044	32.2	5.89	Group
Kalama STP	WA0020320B	75.0	0.018	22.2	1.63	Group
Noveon Kalama, Inc	WA0000281B	74.0	O.044	40.7	7.45	Group
Steelscape, Inc.	WA0040851B	73.5	0.008	57.2	1.89	Group
PGE Trojan OR		72.7	3.6	33.9	511.22	Individual
Port of Kalama		72.2	0.001	22.2	0.08	Group
General Permits and Future Growth					20.0	Group

River Reach/Facility	Permit Number	River Mile	Flow (M^3/sec)	Temperature (°C)	Load (MW)	Form of Allocation
River Mile 72 - River Mile 42						
Riverwood OR		70.2	0.001	24.0	0.07	Group
Cowlitz STP	WA0037788B	68.0	1.183	22.0	109.03	Group
Longview Fiber		67.4	3.33	33.0	455.4	Individual
Rainier OR		67.1	0.028	21.0	2.44	Group
Cytec Industries	WA0039012C	67.0	0.043	18.0	3.23	Group
Houghton International	WA0038814B	67.0	0.00007	27.5	0.01	Group
Longview STP		66.0	0.118	22.2	10.98	Group
Weyerhauser Longview		64.0	2.454	33.0	338.7	Individual
Reynolds		63.0	0.697	20.0	58.21	Group
Stella STP	WA0039152C	56.4	0.0001	22.2	0.01	Group
PGE Beaver OR		53.4	0.048	35.0	7.03	Group
New Source OR		52.8	0.198	30	24.84	Group
GP Wauna OR		42.3	2.16	33.4	301.71	Individual
General Permits and Future Growth					20.0	Group
River Mile 42 - River Mile 4						
Cathlamet STP		32.0	0.006	22.2	0.55	Group
Astoria OR		11.8	0.233	24.0	23.38	Group
Ft. Columbia State Park		7.2	0.0002	22.2	0.02	Group
Bell Buoy Crab Co.	WA0000159B	6.0	0.004	20.0	0.33	Group
Warrenton OR		4.9	0.025	24.0	2.51	Group
General Permits and Future Growth					20.0	Group
River Mile 4 - River Mile 0						
Ilwaco STP	WA0023159B	2.0	0.03	27.5	3.52	Group
Jessies Ilwaco Fish Co.	WA0000361C	2.0	0.033	20.0	2.75	Group
Coast Guard Sta. Cape Disappointment	WA_002422-81	1.0	0.0001	27.5	0.01	Group
General Permits and Future Growth					20.0	Group

Table C-2: Point Sources by River Reach in the Snake River

River Reach/Facility	Permit Number	River Mile	Flow (M^3/sec)	Temperature (°C)	Load (MW)	Form of Allocation
Salmon R - River Mile 138						
Asotin STP		145.0	0.044	21.7	4.02	Group
Potlatch	ID-0001163	139.3	2.14	33.3	298.79	Individual
Clarkston STP		138.0	0.057	26.1	6.26	Group
General Permits and Future Growth					20.0	Group
River Mile 138 - Lower Granite						
General Permits and Future Growth					20.0	Group
Lower Granite to Little Goose						
Lower Granite Dam	WA-002211-1	107.5	0.0002	21.1	0.02	Group
General Permits and Future Growth					20.0	Group
Little Goose - Lower Monumental						
Little Goose Dam	WA-002210-1	70.3	0.0001	21.3	0.01	Group
Lyon's Ferry		59.1	0.01	26.0	1.38	Group
General Permits and Future Growth					20.0	Group
Lower Monumental - Ice Harbor						
Lower Monumental Dam		44.6	0.00004	21.4	0.004	Group
General Permits and Future Growth					20.0	Group
Ice Harbor - Columbia R.						
Ice Harbor Dam		9.7	0.00004	21.5	0.004	Group
General Permits and Future Growth					20.0	Group

Columbia/Snake Rivers Temperature TMDL
Preliminary Draft September 13, 2002
Appendix D General Permits

The National Pollutant Discharge Elimination System authorizes the issuance of general permits to cover the discharge of categories of dischargers (40 CFR 122.28). The general permit may be written to regulate storm water point sources or categories of point sources other than storm water if the sources in the category all:

- involve the same or substantially similar operations;
- discharge the same types of wastes;
- require the same effluent limitations or operating conditions;
- require the same or similar monitoring; and
- in the opinion of the State Director or EPA Regional Administrator, are more appropriately controlled under a general permit than under individual permits.

Table 1 lists the general permits that have been issued in Idaho, Oregon and Washington that could potentially result in discharges to the mainstem of the Columbia or Snake Rivers within this TMDL area. The permits listed as issued by EPA are general permits for facilities in Idaho as well as federal facilities and facilities on Indian lands in all three states.

The discharges allowed by the general permits listed in Table 5-9 are not expected to be a factor influencing temperature in the Columbia and Snake River main stems. We believe that the contribution to temperature load from the sources covered by these general permits is minimal especially when compared to the temperature loads from the large individual permits and the impacts of the dams. Therefore, the wasteload allocations for the general permits are included in the group allocations for each reach as explained in Section 5.6.2 of the TMDL. Under the TMDL, facilities can continue to be covered under the general permits and discharge as authorized by those permits. The nature of the facilities, the relative sizes of the discharges and the main stem, the seasonality of the discharges and the limitations and requirements in the permits all contribute to this finding. However, effluent monitoring for temperature should be included in all of the general permits so that the states can keep track of the loadings allowed to the river via the group allocations. The following sections describe the general permits and discuss the reasons leading to the conclusion that these sources have minimal impacts on water temperature and should be included in the group allocations.

Table 1: General NPDES Permits

Agency	Permit Name and Number	Number of Facilities
EPA	Concentrated Animal Feeding Operation IDG010000 (EPA, 1997)	0
EPA	Aquaculture and On-site Fish Processors IDG130000 (EPA, 1999)	0
EPA	Stormwater Permits for Industries and Municipalities (EPA, 2000)	21
EPA	Stormwater Permits for Construction (EPA, 1998)	20 total/3 current
ODEQ	Cooling Water/Heat Pumps 0100 (ODEQ, 2002)	1
ODEQ	Filter Backwash 0200 (ODEQ, 2002)	0
ODEQ	Fish Hatcheries 0300 (ODEQ, 2002)	5
ODEQ	Log Ponds 0400 (ODEQ, 2002)	0
ODEQ	Boiler Blowdown 0500 (ODEQ, 2002)	0
ODEQ	Suction Dredges 0700 (ODEQ, 2002)	0
ODEQ	Seafood Processing 0900 (ODEQ, 2002)	6
ODEQ	Stormwater Permit for Gravel Mining 1200A (ODEQ, 2002)	1
ODEQ	Construction that Disturbs Five or More Acres 1200C (ODEQ, 2002)	5
ODEQ	Construction that Disturbs Five or More Acres - Government Agencies 1200CA (ODEQ, 2002)	0
ODEQ	Construction Activities, 1200-C Permit Administered by DEQ Agents 1200CM (ODEQ, 2002)	0
ODEQ	Industrial Stormwater 1200Z (ODEQ, 2002)	21
ODEQ	Oily Stormwater Runoff, Oil/Water Separators 1300 (ODEQ, 2002)	1
ODEQ	Tanks Cleanup and Treatment of Groundwater 1500A (ODEQ, 2002)	2
ODEQ	Washwater 1700A (ODEQ, 2002)	0
ODEQ	Non Contact Geothermal 1900 (ODEQ, 2002)	0
Ecology	Boatyard General Permit (Ecology, 2002)	2
Ecology	Dairy General Permit (Ecology, 2002)	0
Ecology	Sand and Gravel General Permit (Ecology, 2002)	3
Ecology	Stormwater General Permits (Ecology, 2002)	39
Ecology	Upland Fin Fish Hatching and Rearing (Ecology, 2002)	8
Ecology	Water Treatment Plant (Ecology, 2002)	3
Ecology	Fruit Packers (Ecology, 2002)	14

Fish Hatcheries and Aquaculture

All three agencies have issued general permits for facilities that hatch and or rear fish and discharge water from the rearing facilities to surface waters. Coldwater facilities are not expected to have an impact on surface water temperature. There is some potential for impact from facilities that rear warm water fishes like catfish or tilapia. The general permit issued by Washington Department of Ecology (Ecology) required facilities to monitor effluent temperature during their first year of operation under the general permit. The finding of that monitoring effort was that the "...facilities do not have a reasonable potential to exceed these parameters" and the subsequent general permit included no temperature monitoring or effluent requirements. The EPA general permit includes a temperature monitoring requirement to ensure that warm water facilities do not effect in stream temperatures. Given the Ecology finding and the small number of these facilities that discharge to the Columbia and Snake River main stems, it is reasonable to include fish hatcheries and aquaculture facilities in the group allocations of the TMDL.

Dairy and Animal Feeding Operations

Ecology and EPA have issued general permits that govern the discharge from agricultural livestock operations. Both permits prohibit discharge to surface waters except during storm events that equal or exceed the 1 in 25 year 24 hour rainfall. Given that the facilities are not authorized to discharge except during unusual rain events it is reasonable to include dairies and combined animal feeding operations in the group allocations of the TMDL.

Sand and Gravel

Ecology has issued a general permit for sand and gravel operations. They found that temperature increases and decreases for process water, mine dewatering water, and stormwater are primarily a result of ambient air temperature and solar influences. Processing by the facilities covered under this permit does not typically transfer significant thermal energy. Temperature decreases have not been identified as a significant environmental concern but there are more than 300 rivers in the state that are listed for water quality temperature excursions as a result of high temperatures. The temperature of discharges to surface water during the warm weather months are therefore a concern. The permit requires monitoring of temperature for all discharges to surface water during the warm weather months. Monitoring results will be used to determine if a temperature limit will be required in the next permit revision. It is reasonable to include sand and gravel operations in the group allocations of the TMDL pending analysis of the required monitoring data.

Cooling water/heat pumps

ODEQ has issued a general permit for discharges of non-contact cooling water, defrost water, heat pump transfer water, and cooling tower blowdown. Also included are cooling and sump water discharges from hydropower facilities. The permit includes daily maximum effluent limitations of 0.5 mgd (millions/day) for flow and 100 °F for temperature. It also includes a minimum dilution requirement:

> "During periods of discharge, the receiving stream flow shall be at least four (4) times that of the discharge for each degree Fahrenheit the temperature of the discharge is above that of the receiving stream. The following example illustrates the use of this formula. Example: If a discharge is 0.1 mgd at 100 degrees F and the receiving stream temperature is 60 degrees F, the receiving stream flow must be at least 16 mgd.
>
> $$(100-60)*(4)*0.1 = 16\text{mgd."}$$

The permit further states that facilities that discharge to water quality limited streams and meet the dilution requirements and the effluent limitations will be deemed to satisfy the requirement of developing and implementing a surface water temperature management plan. Given the maximum flows authorized by this permit, the minimum dilution requirements and the enormous dilution available in the Columbia and Snake rivers, it is reasonable to include cooling water/heat pumps in the group allocations of the TMDL.

Filter backwash

ODEQ has issued a general permit for the discharge or land application of filter backwash, settling basin, and reservoir cleaning water which have been adequately treated prior to discharge. Flushing of raw water intakes after storm events and spring runoff are also allowed. The permit requires that the stream flow provides a 30:1 minimum dilution ratio with the effluent during periods of discharge. Facilities that do not meet that criterion are not eligible for the permit. The permit further states that facilities that discharge to water quality limited streams and meet the dilution requirements will be deemed to satisfy the requirement of developing and implementing a surface water temperature management plan. Given the minimum dilution requirements and the enormous dilution available in the Columbia and Snake rivers, it is reasonable to include filter backwash in the group allocations of the TMDL.

Log ponds

ODEQ has issued a general permit for discharge from wet storage facilities (log ponds) that receive no sewage and process wastewater; cold deck sprinkling; and log yard runoff where sprinkling occurs. No discharge is permitted from log ponds, log yards and log decks where sprinkling occurs from May 1 to October 31. If due to unseasonable wet weather or other reasons beyond the control of the permittee, it becomes necessary to discharge from a log pond during the May 1 through October 31 period or at a time when a 50:1 dilution is not available, the discharge may be permitted upon written approval by the Department. From November 1 - April 30 discharge is permitted provided that at least a 50:1 dilution is available in the receiving stream. Given that no discharge is allowed in the summer, the minimum dilution requirements and the enormous dilution available in the Columbia and Snake rivers, it is reasonable to include log ponds in the group allocations of the TMDL.

Boiler blowdown

ODEQ has issued a general permit for surface water discharge, discharge to evaporation/detention ponds, and land application of boiler blowdown that does not exceed 40 gallons per minute. The permit contains daily maximum effluent limitations of 0.57 mgd for flow and 100 °F for temperature. It also contains a minimum dilution requirement.

> "During periods of discharge, the receiving stream flow shall be at least four (4) times that of the discharge for each degree Fahrenheit the temperature of the discharge is above that of the receiving stream. The following example illustrates the use of this formula.
> Example: If a discharge is 0.05 mgd at 100 degrees F and the receiving stream temperature is 60 degrees F, the receiving stream flow must be at least 8 mgd (12.4 cfs).
> (100 - 60) x (4) x (0.05) = 8 mgd."

The permit further states that facilities that discharge to water quality limited streams and meet the dilution requirements and the effluent limitations will be deemed to satisfy the requirement of developing and implementing a surface water temperature management plan. Given the maximum flows authorized by this permit, the minimum dilution requirements and the enormous dilution available in the Columbia and Snake rivers, it is reasonable to include boiler blowdown in the group allocations of the TMDL.

Suction dredges

ODEQ has issued a general permit for discharges from suction dredges, not to exceed 40 horsepower, used for recovering precious metals or minerals from stream bottom sediments. The suction dredging activity is not allowed to create dams or divert a waterway. Channel alteration is not allowed to result in a wider wet perimeter or shallower water depth within the stream. Suction dredging performed in this manner is not likely to add process heat to the stream. Suction dredging is allowed in streams designated as water quality limited for temperature, provided that all conditions and limitations of the permit are met. Given that the permit does not allow channel alterations that widen or deepen the water in the stream, it is reasonable to include suction dredging in the group allocations of the general permit.

Seafood processing

ODEQ has issued a general permit for discharge of process wastewater and storm water from seafood processing facilities. It also covers the disposal of seafood processing residuals through the fisheries enhancement program. This permit does not cover wastewater discharged from surimi processing activities. Temperature is not considered a parameter of concern for seafood processing. The permit does include a requirement to achieve all water quality standards at the edge of a mixing zone with a radius of 100 feet. Given that seafood processing is not likely to add heat and that the permit requires compliance with all water quality standards at the edge of the mixing it is reasonable to include seafood processing in the group allocations of the general permit.

Tanks cleanup and treatment of groundwater

ODEQ has issued a general permit for discharge of water contaminated with petroleum hydrocarbons from groundwater or surface water cleanup operations. The permit contains a minimum dilution requirement of 10:1 with the receiving stream. The permit further requires that water quality standards be achieved at the edge of a mixing zone with a radius of 10 meters. Given that the permit requires 10:1 dilution and compliance with all water quality standards at the edge of the mixing zone, it is reasonable to include tanks cleanup and treatment of groundwater in the group allocations of the TMDL.

Washwater

ODEQ has issued a general permit for vehicle, equipment, building, and pavement washing activities that discharge wash water to surface waters or storm sewers. This permit covers discharges from fixed washing operations and mobile washing operations. Individual wash water discharges are not expected to cause a measurable increase in stream temperatures. Facilities that discharge to water quality limited streams and meet the terms and conditions of this permit will be deemed to satisfy the requirement of developing and implementing a surface water temperature management plan. Given that washwater discharges are not likely to increase stream temperatures, it is reasonable to include washwater in the group allocations of the TMDL.

Non contact geothermal

ODEQ has issued a general permit for the following facilities:

Facilities intercepting water from geothermal artesian springs which would have otherwise naturally discharged into surface water; where the intercepted geothermal water is used in non-contact heat exchange processes; and, where the spent geothermal wastewater is returned to the point of interception.

Facilities using a well to intercept geothermal water which would have otherwise naturally discharged into surface water; where the intercepted geothermal water is used for non-contact heat exchange processes; and where the spent geothermal wastewater is discharged into the same surface water body as would have occurred under natural conditions.

Facilities intercepting water from a geothermal well or spring for use in non-contact heat exchange processes where disposal of the spent geothermal wastewater is by land application.

The permit requires that effluent flow and temperature not exceed the natural geothermal source flow and temperature. Given that the permit does not allow the addition of heat and requires the discharge to be back to the stream it would normally have flowed to, it is reasonable to include non contact geothermal uses in the group allocations of the TMDL.

Fruit Packers

Ecology has issued a general permit for the discharge of wastewater from fruit packers to surface water. Discharges to surface waters will not be allowed under this general permit if either 1) the water body is designated as a WQPA, or 2) the effluent exceeds a water quality criterion and the receiving water is on the most current 303(d) list for that criterion. Furthermore, 90% of the facilities discharge less than 0.1 CFS and the discharge reported is 0.4 CFS. Given the requirements of this permit and the very small discharge flows, it is reasonable include fruit packers in the group allocations of the TMDL.

Water Treatment Plants

Ecology has issued a general permit for discharge of filter backwash from water treatment plants. Since there are more than 300 rivers in the state that are listed for water quality temperature excursions as a result of high temperatures the temperature of discharges to surface water during the warm weather months are a concern. The permit requires monitoring of temperature in the effluent. Monitoring results will be used to determine if a temperature limit will be required in the next permit revision. It is reasonable to include water treatment plants in the group allocations of the TMDL pending analysis of the required monitoring data.

Stormwater

All three agencies have issued general permits for the discharge of stormwater from municipalities, industries and construction activities. Typically the stormwater pollutants of most concern have been total suspended solids, oil and grease, nutrients, pesticides, other organics, pathogens, biochemical oxygen demand, heavy metals and salts (Ecology, 2001). The general permits require the development of pollution prevention plans and the use of best management practices to control the discharge of pollutants to surface waters.

Direct stormwater flows, as well as, effluent from stormwater ponds can impact receiving stream temperature. For example, Johnson et al (1995) reported rapidly-increasing stream temperatures at locations downstream from storm water outfalls during summer rainfalls, and storm water temperatures exceeding 80 °F in River Falls, Wisconsin. Schueler and Holland (2000) reported that permanent stormwater ponds can act as a heat sink during the summer and discharge warmer water during storms and base flow conditions.

In River Falls, stormwater temperature during 10 days in June varied from 59.5 to 82.6 °F. Factors contributing to the variation in temperature appeared to be temperature of the impervious surface drained, the time of day when rainfall occurs, amount of rainfall, and intensity and duration of rainfall. For example, a 0.65-inch rainfall beginning at 6:30 in the morning, with air temperature near the daily minimum of 59 °F, resulted in a peak stormwater temperature of 64.6 ° F; and a 0.33-inch rainfall beginning at 9:00 in the evening. with air temperature somewhat lower than the daily maximum of 85 degrees F, resulted in a peak stormwater temperature of 74.8 ° F (Schueler and Holland, 2000).

Summer stormwater may be a significant issue in the Midwest where hot temperatures mingle with the wettest months of the year. Historical data from the Midwest Regional Climate Center for Minneapolis, MN (near River Falls, WI) shows average monthly rainfall of 4.34 inches in June, 4.04 inches in July and 4.05 inches in August (Midwest Regional Climate Center, 2002) . In the Columbia Basin, on the other hand, the summer months have the lowest rainfall. Table shows the average monthly precipitation at various locations within the basin as provided by the Western Regional Climate Center (2002).

Table : Average monthly precipitation in inches within the Columbia Basin.

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Coulee Dam	1.09	0.94	0.86	0.78	1.15	0.94	0.56	0.50	0.52	0.66	1.31	1.44	10.75
Wenatchee	1.25	0.92	0.62	0.53	0.56	0.74	0.21	0.40	0.39	0.60	1.23	1.45	8.91
Priest Rapids	0.85	0.68	0.64	0.48	0.42	0.38	0.19	0.25	0.31	0.47	1.02	1.15	6.86
Lewiston	1.24	0.91	1.06	1.20	1.49	1.40	0.64	0.71	0.78	1.00	1.20	1.15	12.78
Ice Harbor	1.21	0.98	0.99	0.76	0.94	0.72	0.24	0.46	0.48	0.81	1.43	1.38	10.40
Kennewick	1.10	0.75	0.67	0.49	0.61	0.47	0.23	0.29	0.33	0.59	1.03	1.12	7.69
Hood River	5.23	3.78	3.11	1.64	1.05	0.79	0.20	0.39	0.94	2.40	4.95	5.75	30.21
Portland	6.62	4.6	4.71	2.7	2.01	1.58	0.37	0.73	1.78	3.68	6.02	7.74	42.51
Longview	6.24	4.98	4.64	3.27	2.51	2.12	0.89	1.30	2.11	4.15	6.75	7.37	46.33

Precipitation is very low throughout the basin during the summer months. The greatest probability of precipitation during the summer is west of the Cascade Mountains. Limited stormwater temperature data from Seattle, WA shows August stormwater temperatures of 19 °C (~66 °F). The chances for sudden storm events during hot days onto hot pavements, the conditions that cause 80 °F stormwater runoff in the Midwest appear to be rare west of the Cascade Mountains. East of the mountains, rainfall events are rare during the hot summer months. Given the low rainfall in the Columbia Basin, especially during the summer and the large flows in the Columbia and Snake Rivers it is reasonable to include stormwater in the group allocations of the TMDL.

We believe, for the reasons discussed above, that the contribution to temperature load from the sources covered by these general permits is minimal especially when compared to the temperature loads from the large individual permits and the impacts of the dams. However, effluent monitoring for temperature should be included in all of the general permits so that the States can keep track of the loadings allowed to the river via the group allocations.

References Cited

Environmental Protection Agency. 1997. Final General NPDES Permit for Concentrated Animal Feeding Operations (CAFO) in Idaho. Federal Register. Vol 62. No 80.

Environmental Protection Agency. 1998. NPDES General Permits for Storm Water Discharges Associated with Construction Activities. Federal Register. Vol 63. No 31.

Environmental Protection Agency. 1999. Final NPDES Permit for Aquaculture Facilities and Associated On-Site Fish Processing Facilities Operating in Idaho. Federal Register. Vol 64. No 171.

Environmental Protection Agency. 2000. NPDES General Permits for Storm Water Discharges Associated with Industrial Activities. Federal Register. Vol 65. No 210.

Johnson, K. 1995. Urban Stormwater Impacts on a coldwater resource. Presentation to the Society of Environmental Toxicology and Chemistry (SETAC). Second World Congress. Vancouver, B.C.

Midwest Regional Climate Center. 2002. Historical Climate Data. Precipitation Summary. Station: 215435 MINNEAPOLIS WSFO AP, MN. http://mrcc.sws.uiuc.edu/Precip/215435_precipsum.html

Oregon Department of Environmental Quality. 2002. General Permit Documents. http://www.deq.state.or.us/wq/wqpermit/permitdocs.htm

Schueler, T.R. and H. Holland. 2000. *The Practice of Watershed Protection.* The Center for Watershed Protection. Ellicott City, MD.

Washington Department of Ecology. 2002. Washington Department of Ecology Water Quality Program. Permits. http://www.ecy.wa.gov/programs/wq/permits/index.html.

Western Regional Climate Center. 2002. Idaho Climate Summaries. http://www.wrcc.dri.edu/summary/climsmid.html.

Western Regional Climate Center. 2002. Washington Climate Summaries. http://www.wrcc.dri.edu/summary/climsmwa.html.

COLUMBIA RIVER

Columbia River Tributaries	State or Tribe	USGS Station	River Mile	Drainage Area (sq mi)	USGS Ave Flow (cfs)	303(d) List	RBM 10 Model
Wallacut River	WA		3.2	6.3			
Dairy Creek	OR	14205800	7.7	147	40.8		
Chinook River	WA		9.0	11.7			
Skipanon Waterway	WA		10.7				
Youngs River	OR	14251500	12	119	177.5		
Deep River	WA		20.5	12.5			
Grays River	WA	14250000	20.8	124	669	yes	
Bear Creek	OR		21.7				
Big Creek	OR	14306900	27	33.6	90.5		
Gnat Creek	OR		27.4				
Jim Crow Creek	WA		29	7.7			
Skamokawa Creek	WA		33.3	50.6			
Hunt Creek	OR		38.9				
Mill Creek	WA		53.9	29.1	120.6		
Abernathy Creek	WA	14246000	54.3	28.7	108	yes	
Germany Creek	WA		56.2	22.5		yes	
Coal Creek Slough	WA		56.4	26.9			
Nice Creek	OR		67.2				
Fox Creek	OR		67.4				
Cowlitz River	WA	14243000	67.7	2480	9623		yes
Kalama River	WA	14223600	73.1	205	315	yes	yes
Goble Creek	OR		73.6			yes	
Tide Creek	OR		76.2				
McBride Creek	OR		82.5				
Lewis River	WA	14220500	86.5	1046	4837	yes	yes
Lake River	WA		87.5			yes	
Willamette River	OR	14211720	101.5	11200	34205	yes	yes
Camas Slough	WA		118.1				
Sandy River	OR		120.5	502	2183	yes	yes
Washougal River	WA	14143500	120.7	108	879.9		
Stiegerwald Lake	WA		123.3				
Lawton Creek	WA		128.1				
Bridal Veil Creek	OR		131.5	4.9			
Woodward Creek	WA		141.4	8.1			
McCord Creek	OR		142.3				
Moffett Creek	OR		143.2				
Tanner Creek	OR		144.2				
Eagle Creek	OR		146.3	35.5			

Ruckel Creek	OR		147				
Rock Creek	WA		150	41			
Herman Creek	OR		150.7	19.5			
Wind River	WA	14128500	154.5	226	1206.2		
Summit Creek	OR		158				
Collins Creek	WA		158.2				
Lindsey Creek	OR		158.8				
Starvation Creek	OR		159.7				
Dog Creek	WA		161.1				
Drano Lake	WA		162	136			
Mitchell Creek	OR		163.2				
White Salmon River	WA	14123500	168.3	390	1125		
Hood River	OR	14120000	169.4	349	1030	yes	yes
Rock Creek	OR		174.7				
Mosier Creek	OR	14113200	174.9	51.6	29		
Catherine Creek	WA		177				
Major Creek	WA		177.4				
Klickitat River	WA	14113000	180.4	1350	1599		yes
Chenoweth Creek	OR		187.3				
Fifteenmile Creek	OR		192.4	365			
Deschutes River	OR	14103000	204.1	10500	5839	yes	yes
John Day River	OR	14048000	218	7840	2095	yes	yes
Rock Creek	WA		225.4	222			
Chapman Creek	WA		236.4	23.6			
Pine Creek	WA		249.2	63.6			
Willow Creek	OR	14036000	252.5	850	26.3	yes	
Alder Creek	WA		257.7	196			
Six Mile Canyon	OR		259	140			
Four Mile Canyon	WA		286.4	86.4			
Umatilla River	OR	14033500	289	2290	477	yes	yes
Spukshowski Canyon	WA		301.5	31.1			
Walla Walla River	WA	14018500	314.6	1758	576	yes	yes
Yakima River	WA	12512000	335.2	6155	3569	yes	yes
Esquatzel Waterway*	WA				141	yes	
Pasco Wateway*	WA				173		
PE 16.4*	WA				248	yes	
WB 05*	WA				92	yes	
WB10*	WA				34		
Priest Rapids Dam			397.2				
Sourdough Canyon	WA		400.2	9.7			
Alkall Canyon	WA		404.3	26.8			
Hanson Creek	WA		406.5				
Lower Crab Creek*	WA	12472600	410.8	4864	275	yes	yes

Johnson Creek	WA	14230000	416	58.8	202.3		
Sand Hollow*	WA	12464606	419.5	54.6	113	yes	
Spring Cayuse Creek	WA		425.4				
Whiskey Dick Creek	WA		426.3	34.2			
Skookumchuck Creek	WA		427.7	15.1			
Brushy Creek	WA		433	45.2			
Tekison Creek	WA		437.5	32.9			
Tarpiscan Creek	WA		445.4	24.5			
Moses Coulee	WA		447.3	92.4			
Colokum Creek	WA		450	35.1			
Rock Island Creek	WA		454.5	87.4			
Stemilt Creek	WA		461.9				
Squilchuck Creek	WA		464	27.8			
Wenatchee River	WA	12462500	468.4	1327	3313	yes	yes
Swakane Creek	WA		474.4	20.7			
Entiat River	WA	12453000	483.7	419	646		yes
Navarre Coulee Creek	WA		492.3				
Chelan River	WA	12452500	503.3	924	2060		yes
Corral Creek	WA		507.2				
Methow River	WA	12450500	523.9	1794	1581	yes	yes
Watson Draw	WA		524.8	9.8			
Indian Dan Canyon	WA		526.8	16.6			
Central Ferry Canyon	WA		527.5	8			
Swamp Creek	WA		531.2	57.1			
Okanagan River	WA Colville	12447300	533.5	8340	3145	yes	yes
Dry Creek	WA		542.2	8.6			
Foster Creek	WA		544.6	321			
Tumwater Creek	Colville		555.3				
China Creek	WA		574.9	16.1			
Coyote Creek	Colville		579	28.7			
Nespelem River	Colville	12437505	582.1	224	40		
Moses Creek	WA		588.1				
Sanderson Creek	WA		589.4	16.4			
Peter Dan Creek	Colville		592	15.5			
Sanpoil River	Colville	12435000	615	979	229		
Brody Creek	Colville		621	11.7			
Wynhoff Canyon	WA		621.5	2.5			
Hawk Creek	WA		634	178			
Spokane River	WA Spokane	12433500	638.9	6590	7812	yes	yes
Threemile Creek	Colville		642	126			
Sixmile Creel	Colville		644.5	10.8			
Ninemile Creek	Colville		648	113			
Wilmont Creek	Colville		653.5	51.1			
Alder Creek	Spokane		657				
Hunters Creek	WA		659	40.7			

Nez Perce Creek	Colville		661	22.6			
Harvey Creek	WA		664	35			
Deer Creek	WA		674				
Stranger Creek	Colville	12410500	676.3	82.3	20.2		
Stranger Creek	WA	12410000	676.3	22.8	14.8		
Hall Creek	Colville	12409500	677.5	161	78.8		
Magee Creek	WA		680.7	11.3			
Little Jim Creek	Colville		681.3				
Cheweka Creek	Colville		685.3	20			
Barnaby Creek	Colville		686.4	45.9			
Quillissascut Creek	WA		687.8	11.6			
La Fleur Creek	Colville		690.5				
Martin Creek	Colville		693				
Roper Creek	Colville		695				
Rickey Creek	WA		696.2				
Hallam Creek	WA		698				
Colville River	WA	12409000	699.5	1020	310	yes	yes
Sherman Creek	Colville		700.2	107			
Pingston Creek	WA		705.5				
Kettle River	Colville	12405000	706.4	4140	2946		yes
China Creek	WA		712.6				
Fifteenmile Creek	WA		720.2	16.2			
Lodge Pole Creek	Colville		720.2				
Flat Creek	WA		721.7	15.7			
Crown Creek	WA		726.6	12.6			
Rattlesnake Creek	WA		727.2	4.8			
Onion Creek	WA		730.1	50.5			
Squaw Creek	WA		731.9	4.5			
Five Mile Creek	WA		732.8				
Big Sheep Creek	WA		736.7	22.5			
Deep Creek	WA	12399600	737	191	130		
Scriver Creek	WA		739.6				

* Irrigation return flows used highest measured flow.

SNAKE RIVER

Snake River Tributaries	State or Tribe	USGS Station	River Mile	Drainage Area (sq mi)	USGS Ave Flow (cfs)	303(d) List	RBM 10 Model
Tucannon River	WA	13344500	21.2	504	173	yes	yes
Palouse River	WA	13351000	59.5	3283	614	yes	yes
Alkali Flat Creek	WA		67.2	167			
Deadman Creek	WA		82.7	204			
Penewawa Creek	WA		91.7	46			
Almota Creek	WA		103.8	36			
Clearwater River	ID	13342500	139.3	9640	15430		yes
Tammany Creek	ID		143.7				
Asotin Creek	WA	13335050	145.3	322	114		
Tenmile Creek	WA		150.3	42			
Twelvemile Creek	ID		151.4				
Red Bird Creek	ID		155.5				
Couse Creek	WA		157.6				
Captain John Creek	ID		162.5				
Billy Creek	ID		164.9				
Camp Creek	ID		166.9				
Grande Ronde River	WA	13333000	168.7	3950	3101		yes
Dough Creek	ID		170.7				
Chimney Creek	ID		171				
Middle Creek	ID		171.8				
Anaconda Creek	ID		172.2				
Birch Creek	OR		173.2				
Shovel Creek	ID		174.3				
Corral Creek	ID		175.4				
Cache Creek	OR		177.1				
Garden Creek	OR		178.6				
Coon Creek	OR		180.8				
Cottonwood Creek	ID		181.1				
Jim Creek	OR		182.4				
Pine Creek	ID		183.3				
Cook Creek	OR		183.6				
Frenchy Creek	ID		185				
Cherry Creek	OR		185.3				
First Creek	ID		187.1				
Salmon River	ID	13317000	188.2	14100	11240		yes